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FRONT COVER

Heterospathe califrons, a wonderful new palm from Mindanao, Philippines. See article p. 118. Photo by E.S. Fernando.

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Chambeyronia lepidota, close-up of the crown, photographed at the summit of Mont Panié, New Caledonia by Carlo Morici.

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In the nest issue of PALMS...

A monograph of *Colpothrinax* (including a new species), *Livistona* in Japan, a profile of the Palmetum of Santa Cruz, Canary Islands, and much more!

NEWS FROM THE WORLD OF PALMS

The Middle-East emirate of Dubai recently unveiled plans for a giant palm-shaped resort island. "Palm Island" will be built on reclaimed land extending 5 km (3 miles) into the sea south of Dubai city. The developers claim that it will be visible from the moon. The island will be built in the shape of a huge (date?) palm with 17 leaves surrounded by 120 km (75 miles) of sandy beaches. It will include 2,000 villas, up to 40 hotels, shopping complexes, and the Middle East's first marine park. It sounds like a perfect spot for a future Biennial!

Twenty-meter tall royal palms (*Roystonea*) are commonplace throughout the tropics and subtropics and scarcely something to cause excitement. On the other hand a 19.1 m tall *Roystonea oleracea* in London, England is something unusual. The royal palm in the Palm House at Kew recently burst through the roof of the great curvilinear glasshouse, smashing the glass as the sword leaf broke for freedom. Planted from seed 35 years ago, the palm began to grow very rapidly when it was planted in the renovated Palm House in the mid 1980s. Emma Fox of the Palm House had no option but to fell the palm in June this year. Kew staff suspect that this was the tallest glasshouse palm in the world when it was felled; for a few weeks it overtopped the Chilean wine palm (*Jubaea chilensis*) in the Temperate House, also at Kew, which had until then held the record. The demise of Kew's royal palm attracted wide media coverage, both on television and in the national daily newspapers. Schoolchildren visiting the Palm House at the time were even able to sample royal palm cabbage.

IPS Member Dennis Johnson, of 3726 Middlebrook Ave, Cincinnati OH 45208 (Djohn37@aol.com) sends us the following interesting letter:

"Peter Bacon's interesting article on *Nypa fruticans* in Trinidad (PALMS 45: 57–61. 2001) contributed another piece to the puzzle of this Asian palm in the New World. I would like to add another. In August 1994 I was in western Guyana doing a field survey of palm heart production. Travelling by small boat down the Barima River I was surprised to see naturalized colonies of *Nypa* palm beginning a few miles downstream from Drum Hill at a place called Blackwater. Below Blackwater I saw about 20 colonies, all rather limited in size, on either bank of the river. In some instances the *Nypa* palms appeared to be just getting established behind the leading edge of the mangroves. According to our boatman, who was about 60 years old and had lived his entire life in the region, *Nypa* first appeared around Mabaruma about 20–30 years earlier, and at the time of my visit was said to occur in almost pure stands in some locations, although I did not personally see them. The only reported use of *Nypa* here is the eating of the fruit around Mabaruma. It is worth noting that the palm has no local name, it is simply called *palm*, no doubt because of its relatively recent arrival. Perhaps the *Nypa* propagules were carried into the mouth of the Barima River by the ocean currents from West Africa, as hypothesized by Bacon, became established in sizable colonies and then propagules from those larger colonies borne upstream by tidal currents to form new colonies. The location where I first observed *Nypa* on the Barima is about 25 miles upstream, which suggests a remarkably rapid colonization rate. It would not be surprising to find that there are other unreported coastal colonies of *Nypa* elsewhere in the Guianas, as well as in Venezuela and Colombia."

THE EDITORS

Traditional Farming System of *Supari* (*Areca catechu*) in Rural Bangladesh

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***Supari* tree (*Areca catechu* L.) is commercially the most important palm grown in India, Burma and Bangladesh. It is the predominant crop of home gardens of southern coastal Bangladesh where it is widely grown as a cash crop both along the boundaries of home gardens and as block plantings within them.**

Its important product is the *supari* (nut), an important constituent of mastication along with *pan* (leaves of *Piper betle*) all over Southeast Asia. Cultivation of *supari* palm for nut is an age-old practice. Marco Polo mentioned the habit of chewing of betel-nut (*supari* palm) in 1298 (Blatter 1978). Adams in his translation of Paulus Aegineta refered to the betel-nut as introduced to Materia Medica by the Arabs.

The palm is usually seen as a garden plant, but occasionally, and in certain localities, especially of Western and Southern India, of Sri Lanka and of Burma, where the soil and climate may be exceptionally favorable, it is grown in special gardens along with coconut, plantain, orange, mango, etc., with or without the *pan*. Intercropping of black pepper, nutmeg and spices with betel nut increases the profitability to the farmers (Bhosale et al. 1994; Korikanthimath & Rajendra 1994). Fischer found it growing wild in the Attapadi valley of Malabar in dense evergreen jungle (Blatter 1978).

It is most commonly cultivated in Bangladesh, India and Burma. The tree normally grows on farmland boundaries, homesteads and marginal lands in rural districts. In certain areas, it is cultivated in orchards. The tree is planted from nursery raised seedlings and/or planting wildings. According to Rashid (1991), there were a total of 110 million *supari* trees over an area of 72,600 ha in Bangladesh. Annual production of *supari* is estimated to be 86,060 tons.

There have been a few studies on different aspects of *supari* palm husbandry. A brief account of cultivation techniques and production of *supari* in different districts of Bangladesh was given by Rashid (1991). Davis (1988) described the use of the palm in Indonesia and elsewhere in south and Southeast Asia. The present paper is an attempt to investigate *supari* palm husbandry in relation to

landholding sizes of households in an area of Bangladesh where *supari* tree is abundantly grown.

Materials and Methods

The study was carried out in the district of Comilla where the *supari* palm is a common species cultivated abundantly in homesteads and farmlands. The area falls under Brahmaputra alluvium tract, an important agro-ecological zone of Bangladesh. Soil of the tract is categorized as Meghna Estuarine Floodplain and the dominant texture of the soils is sandy loam. The soils are naturally fertile and are replenished every year by fresh deposition of silt carried down by the floodwaters. The soils are acidic in character and the pH ranges from 5.5 to 6.8 (Hussain 1992).

The study was conducted by interviewing members of rural households. The households were stratified into five categories based on landholding size: (a) landless (up to 0.20 ha), (b) marginal (0.21-0.50 ha), (c) small (0.51-1.0 ha), (d) medium (1.01-2.0 ha) and (e) large (>2.0 ha). Data were collected from two villages by randomly selecting ten households of each household category in each village totaling 100 samples of households. There were 624 households in the study villages. For each household, a semi-structured questionnaire was used to gather the field data on age and distribution of *supari* trees, yield of *supari*, marketing of products and income from the palm products.

Results and discussion

Distribution of *supari* trees in the rural landscape

In the study area, the farmers have access to several small, non-contiguous parcels of land broadly encompassing two ecologically different land types, *ucha* (high level and more or less flat land) and *nichu* (low-level and flat land). *Nichu* areas are normally flooded in the rainy season while *ucha* areas remain above flood levels. The difference in landforms and hence the ecological factors affect the uses to which farmers put the lands. *Nichu* areas are used for growing seasonal crops including rice, other cereals and vegetables.

Ucha areas are suitable for homesteads. A typical homestead in Bangladesh is called *bari*, which contains the houses of different pairs of the extended family, their vegetable gardens, threshing grounds, cattle and poultry sheds, ponds, trees, bamboos and shrubs (Leuschner & Khaleque 1987). Farmers plant most plant species including all timber tree and selected tall fruit trees on the boundary of the homesteads. The plants of homestead edges serve the multiple needs of the farmers not only by providing products but also by acting as a live fence and as boundary demarcation. Small-crowned food and fruit producing trees dominate the part of the home garden near the living quarters, where fruits are safe from pilferage.

When distribution of sampled trees in the study area was examined, 77% of the trees were found on homesteads, 15% on pond banks and 2% on canal banks (Table 1). The rest of the trees were distributed on crop fields and along roadsides. The larger landholders held a higher number of palms in comparison to the lower landholders. However, number of trees in different sites were found significantly ($P<0.0001$) different whereas it was insignificant ($P<0.05$) among the various household categories. The significant variation on the number of *supari* trees in different sites was due to the presence of the highest number of trees (77%) on the homesteads.

Age-class frequency distribution of *supari* trees

Presence of trees of different age-gradations or age-classes is important for sustainable production. If the trees in a particular area consist entirely of mature and over-mature trees, the trees will go out of production at one stage, and sustained annual production will not be possible because of the absence of trees of younger age-classes. Since individuals of younger age-classes replace over-mature trees over time, an appropriate proportion

Table 1: Distribution of sampled *supari* palm in different sites on the rural landscapes.

	Sites				
Household size	Homestead	Pond bank	Canal bank	Crop field	Road side
Landless	342	1	12	0	28
Marginal	293	37	0	0	50
Small	395	209	0	7	47
Medium	592	142	30	9	38
Large	987	131	20	1	18
Total	2609 (77%)	520 (15%)	62 (2%)	17 (1%)	181 (5%)

Table 2: Age-class frequency distribution of sampled *supari* palms growing in the study area.

Household size	Age-class in years 0–7	8–15	16–23	24–31	32–39	>40
Landless	114	113	91	7	58	-
Marginal	150	45	68	48	69	-
Small	177	212	116	55	80	18
Medium	127	300	136	125	55	68
Large	392	67	294	265	78	61
Total	960	737	705	500	340	147
Percentage	28%	22%	21%	15%	10%	4%

of individuals of younger age-classes is also required to make annual production sustainable (Kamaluddin et al. 1998).

Farmers in the study area had *supari* palms of different age-classes (Table 2). When distribution of individuals of different age-classes was examined, the highest number of individuals was found for the 0–7 years age-class. Frequency of over-mature trees was less than the younger and middle-aged trees, due to felling of over-mature trees. When trees become over-mature, usually at an age of more than 32 years, farmers fell them for sale or for domestic purposes.

Since middle-aged trees (16–31 years old) produce more *supari* annually, annual yield in the future will depend on the number of middle-aged trees in the area. Frequency of individuals in the middle-aged classes (16–23 and 24–31 age-classes) was 43 percent. The highest frequency of individuals in the lower age-classes indicates that there was a sustainable regeneration of *supari* palms in the study area. The number of trees among the household categories in different age-gradations was found to be significantly different at $P<0.05$ level of probability.

Production of *supari*

Supari palms generally bear fruit at seven or eight years of age. Fruits are normally harvested every year. The fruiting life of a tree may extend from 30 to 50 or 60 years (Blatter 1978). The tree flowers in February and March and the fruits are ready for harvesting from September to December. Poor professional farmers usually do the plucking of *supari* (nut).

According to farmers, the yield of *supari* varies considerably with tree age, weather conditions, manure applied and site quality. On average each tree produces two bunches of fruit, sometimes three or four. A good bunch gives 200–300 *supari,* and an especially good one about 400. Average rate of *supari* production for the study area was 3.8 *pons* (1 *pon* = 80 *supari*). Younger trees produced 3.2 *pons* per tree per year (Fig. 1). Middle-aged trees (16–23 and 24–31 age-classes) produced the highest amount of nut, on average 5.6 *pons* per tree per year. Farmers believe that the use of both organic and inorganic manure and gentle rainfall during the fruiting period will give better size of the bunches and hence, large number of fruits per bunch. Unfavorable rain and cloudy weather in early fruiting causes many of the young fruits to fall off and allows only a smaller number of *supari* on each bunch to reach maturity. Farmers also believe that fertile and good drainage conditions of soil support the vigorous growth of trees and hence the production of fruits.

In the study area, there were about 15,095 harvestable *supari* trees (more than eight years old)

1. Yield of supari per tree per year of supari palms of different age-classes growing in the study area

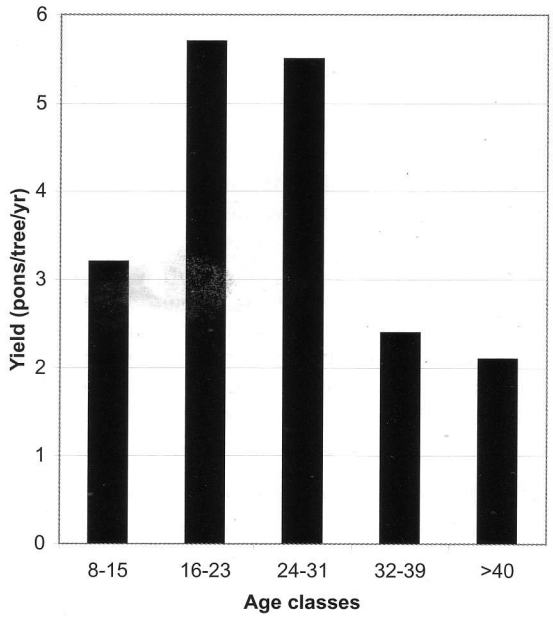


Table 3: Number of trees per household, yield of palm products per year and income per year from sale of raw *supari* and *tari* (Tk. 51.00 = 1US$)

Household size	Average number of palms owned	Average number of harvestable palms	Palm Products: Raw *supari* (*pon*)	Palm Products: *Tari* (kg)	Sale Value: Raw *supari* @ Tk. 45/pon	Sale Value: *Tari* @ Tk. 125/ kg	Income per year (Tk.)
Landless	19.15	13.45	51.11	-	2299.95	-	2299.95
Marginal	19.00	11.50	43.70	-	1966.50	-	1966.50
Small	32.90	24.05	30.46	60.93	1370.70	7616.25	8986.95
Medium	40.55	33.70	42.69	85.37	1921.05	10671.25	12592.30
Large	57.85	38.25	48.45	96.90	2180.25	12112.50	14292.75

yielding about 57,359 *pons* raw *supari* per year. Most of the *supari* is used for making *tari* (dried *supari*); it takes 1.5 *pons* to produce 1 kg of *tari*.

Marketing of Products

Raw *supari* (matured) and *tari* are the principal products for market. Farmers usually pluck mature and ripe *supari* from September to December. Professional male members pick *supari* by climbing the trees; female members usually do the task of making *tari*. *Tari* is made by keeping the nuts in the husk in a heap for a week to make them ferment a bit, and then drying them in the sun for 45 to 60 days till the husk completely separates from the nut. Marketing of products normally follow a short-cut channel and is entirely done by the private sector characterized by three or four intermediaries operating between the producers and the consumers in distant centers. The shortest marketing channel is the direct sale by the growers to the neighboring consumers through primary village markets that are usually held once or twice a week. Landless and marginal farmers usually follow this type of marketing channel. Farmers having a substantial quantity of marketable surplus reach the consumers in the urban centers through *bepari*, (commissioned agent-cum-wholesalers), *arathdars* (wholesalers in city market), *farias* (local itinerant traders) and small resident traders. Farmers sell to the *beparies* in the local markets. *Beparies* supply to the *arathdars* in city markets. *Arathdars* sell to small resident traders and local itinerant traders who sell it to the consumers. The price of raw *supari* and *tari* varies from Tk. 40.00 to Tk. 50.00 per *pon* and Tk. 120.00 to Tk. 130.00 per kg., respectively.

Income from *supari* palm products

Income from *supari* products substantially increases with the increase in household size. Across households average income from the sale of *supari* products per year varies from Tk. 3000.00 to Tk. 14293.00 per household in different household categories (Table 3). In general, farmers with small landholding sell their whole amount of *supari* as raw to get immediate cash whereas rich farmers preserved two-thirds of their entire raw *supari* as *tari* to sell off-season. *Tari* is in great demand when raw *supari* is not available and the price of *tari* is almost three times higher than that of raw *supari*. Poor farmers are given four raw supari (equivalent to Tk. 2.50) for plucking *supari* from a tree of larger farmers.

Planting and felling strategy of farmers

Farmers in the study area were found regularly to fell over-aged and/or less-yielding trees and replace them by planting new ones. They plant *supari* trees under the canopy of other homestead plants. Two-year old seedlings are normally transplanted for better survivability. Small and marginal farmers usually purchased saplings (Tk.5.00 per saplings) from nearby markets. Farmers with medium and large landholdings raise nurseries. A nursery is prepared in a shady place near the homestead, where in October and November, ripe *supari* from mature trees are sown in parallel ridges a few centimeters apart. The nuts are slit slightly at the crown. The nursery is covered with straw or palm leaves till the seeds germinate in June or July of the following year. For high land the seedlings are transplanted in June–July, for low land in March–April. In the first transplanting, the *supari* palms are placed about three to four meters apart. When the first have come to bearing fruit, a second regular transplanting takes place. Similarly, when the second generation have come to bearing, a third regular transplanting also takes place and so on. As a result a regular age-gradation has been maintained.

Constraints in *supari* palm husbandry

Constraints faced by farmers as mentioned by the respondents during the study include crop loss

due to pests and diseases, shortages of land mainly for marginal and small farmers, distantly located markets, difficulties of communication and conflicts over land and tree tenure. There is no easy solution for shortage of land. There is not enough unutilized public land for distribution among landless or small farmers. Marginal land along roads and highways and such other public land could be distributed among local landless and small farmers giving use rights. Land and tree tenure conflicts, particularly those which emerge during family separation, are normally resolved locally by village leaders or local administrative units.

Farmers are generally reluctant to use insecticides because of the additional cost involved and in some cases due to non-availability of appropriate insecticides. Rotting and shedding of young fruits are common in the study area. Individual trees, which are severely attacked by insects every year and/or exhibit rotting and shedding of young fruits for several consecutive years, are felled and replaced by new ones. Selection of pest and disease resistant genotypes for production is an important area of research.

Conclusions

Climatic and edaphic factors in the study area are favorable for luxuriant growth and yield of *supari* palm. The physical factors together with a huge demand of *supari* have made it the most dominant tree in the agroforests. Landholding sizes of farmers are the characteristic of rural Bangladesh and play an important role in household economy. This is particularly true for the case of *supari* trees in the study area where numbers of *supari* trees increased with the increased landholding sizes of farmers and thus proportionately determined the sizes of annual household incomes from *supari* palm husbandry. Replacement of over-aged, diseased or low-yielding trees with new plantings has made it a sustainable crop and a sustainable source of annual household income. Availability of planting materials, ease of establishment, low investment in managing trees, long fruit bearing period and large market demand of *supari* are some of the opportunities for farmers for growing *supari* trees and generating sustained household income. However, supply of improved planting stocks and infrastructure development for marketing may be areas to be considered in promoting *supari* palm husbandry in rural areas.

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PALM RESEARCH IN 2000

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continued on p. 136

Tropical Attitudes in Northern Latitudes

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"This is where our pond is going to be." The hole was the size of a basketball in our back yard. I paused, thinking, "Pond? He never said anything about a pond!" I dared not make a disparaging remark out loud and said, "OK." Little did I know at the time that we would be growing palm trees in Oregon. No plans were drawn. The ever-changing diagrams existed only in Gary's head.

We moved into a house which had been vacant for a year. The weeds were waist high. A holly tree dropped prickly leaves that defied decomposition. The pear tree was dead. An ugly shed loomed in the corner. An ivy-covered back fence and a fig tree were the only features that escaped our chainsaws and shovels.

The pond construction required many weekends to complete. Behind it we built an oversized planter box. Off to the nursery we went in search of the perfect plant, not sure at the time what the plant would be. We came home with large tub of thickly clumped *Chamaerops humilis*. "Tropical attitudes in northern latitudes" became our mission statement. It was the beginning of an obsession. As we located landscapes with palms around Portland, we altered our routes to the nurseries so we could see them.

The process of our landscaping was unwritten and unplanned, but yet it was methodical. Only one section at a time received our attention. In the beginning stages, our yard looked like a movie set. The one section of the yard that looked really nice ended abruptly, and the remainder of the yard was hard-packed dirt, debris, tools and materials. During the first year, one quarter of the yard got done.

The second year, I came home to find Gary with a shovel in hand once again. He was digging a trench. "This is where our sunroom is going to be." Again I paused, thinking, "Sunroom? When did he ever say anything about a sunroom?" Within a week, he dug a big trench, carving out the outline of our sunroom.

We got our lawn chairs and set them in our sunroom-to-be and enjoyed the one quarter of our yard that looked nice. I looked along the back fence and noticed that Gary had placed the dirt from his trench in an even height to form a raised bed with a curved edge. Accident or design? I did not dare to ask. Then our focus shifted to the ugly shed. Suddenly, we couldn't stand that shed another day and tore it down.

It wasn't long before I found Gary with his shovel again, digging another hole. A big hole. "This is where our second pond is going to be." I thought, "Another pond? What about the sunroom?" I said, "I want a waterfall this time!" He muttered something under his breath and kept digging. The second pond was bigger and more difficult than the first. We ordered lots of rocks, moved each one at least twice. Then came the concrete, which I mixed, and Gary did the rest.

A kidney-shaped curve jutted into the pond from the back side. This time we knew before going to the nursery that a palm tree had to go in that spot. We located a *Trachycarpus fortunei* with two feet of trunk at a local nursery (Fig. 1). It was the first of many *Trachycarpus* to enter our landscape. Many different plants contributed to our little



1. The *Trachycarpus fortunei* (right) was in the ground five years at the time this photograph was taken. The bananas (left) were seasonal plants.

piece of the tropical look, but it was always the palms that drew the most comments from visitors.

We grew fourteen varieties of bamboo, ranging from timber bamboo to dwarf varieties. We also grew canna, elephant ears, ferns and bananas. The bananas and elephant ears, of course, were seasonal. Every fall we would bring the bulbs inside and replant in the spring, and we also grew citrus in containers which we brought inside for the winter. In addition, we had a pineapple guava which was grafted onto a hardy root stock, which we were able to grow outside. It was hardy to 5°F (-15°C) and produced delicious fruit.

Our expanding collection of hardy palms consisted mostly of *Trachycarpus fortunei* from local nurseries, supplemented with additional varieties purchased through mail order (*T. martianus*, *T. takil* and *T. wagnerianus*). We never had a problem with *Trachycarpus* surviving the winters. We had about a dozen *Chamaerops humilis* of various sizes which developed fungus problems after the severe winter of '95–96. We were too inexperienced at the time to recognize the problem. Had we known then what we know now, we could have saved them.

That same winter our *Phoenix dactylifera* and *Washingtonia robusta* succumbed. They were palms which we knew would be marginal, but Gary likes to push his zonal limits. To protect these palms during the winter, we used corrugated sheets of plastic and formed them into a cylinder around each palm. On especially cold days, fabric was draped over the top. This was sufficient for a mild winter, but the winter that killed them was unusually harsh for the region.

As our landscape developed, our privacy increased. The lush green foliage of the bamboo surrounded the perimeter of the yard, obscuring all view of neighboring houses (Fig 2). The cascading waterfall and the wind rustling through the bamboo diminished the sounds of the city. The high maintenance of skimming bamboo leaves out of the pond became a labor of pure enjoyment while we watched the fish swimming in the pond and the palm trees reflecting in the water. It was truly an urban oasis, and we dubbed our garden as the "Nor' Palm Palmetum."

Our garden began to capture the attention of passers-by. Sometimes we would look out the window and see people stopping their cars in the street and staring at our yard with their mouths open. The best fun of all was to watch the expressions of new visitors as they entered the back yard for the first time. Eyes would light up and exclamations would pour forth. The palm trees always sparked the most curiosity. One neighbor asked if they were real. Invariably we

would explain the cold tolerance of *Trachycarpus* and people would be amazed that palms would grow – and thrive – outdoors in Oregon (Fig 3).

We enjoy sharing our love of palm trees as much as we cherish the palms themselves. It was a beacon that attracted people who were curious or who shared a common interest. New friendships were formed and our sense of community was strengthened. The garden itself is a unique form of expression, a living canvas that is ever-changing. The rewards are everlasting.

Fig. 2 (top). An earlier photograph of our original *Trachycarpus fortunei* taken the second year of landscaping. Fig 3 (bottom). In the fourth year, we raised the grade of the garden by 45 cm (18 in) with a truckload of mushroom compost. A gravel path leading to the back gate created a cold air drainage avenue, and a canopy of bamboo kept the back yard almost frost-free. From left to right in foreground: *Washingtonia robusta, Butia capitata* and *Chamaerops humilis*.





A New Species of *Heterospathe* with Undivided Leaves from the Philippines

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This new species of *Heterospathe* is most remarkable for its beautiful, erect, and consistently entire or undivided, bifid leaves. It has great horticultural potential.

The central and eastern parts of Mindanao Island, among other areas in the Philippines, remain undercollected for palms (Fernando 1990a). One elegant new species in the genus *Heterospathe* Scheff. (see Front Cover) has very recently been discovered in forests on ultramafic rocks on the northeastern part of the island and is described below. This adds to the 11 species previously recorded for the genus in the Philippines (Fernando 1990a, 1990b).

Heterospathe califrons *Fernando,* **sp. nov.,** Fig. 1

Habitu solitario vaginis foliorum et petiolis persistentibus *Heterospathe brevicauli* Fernando affinis sed foliis indiviso-bifidis distinctissima. Typus: Philippines, Mindanao Island, Surigao del Sur Prov., Carmen, *Fernando 1567 & Sotalbo* (Holotypus LBC; isotypi BH, K, PNH, PUH).

Solitary, moderate, unarmed, pleonanthic, monoecious, undergrowth palm to 2.7 m tall. *Stem* erect, rough-ringed, to ca. 1.5 m tall, ca. 6 cm diam.; internodes to 1 cm long. *Leaves* undivided, bifid (Fig. 2), to 13 in crown, erect, arching at maturity; emerging leaves green; leaf including petiole and sheath to 2 m long; sheaths not forming a well-defined crownshaft, each to 24 cm long, the edges fibrous and marcescent; petiole green, only occasionally light purple, ca. 85 cm long, deeply channelled adaxially, the edges sharply angled, convex abaxially and sparsely puncticulate; sheath and petiole persistent on the stem; mid-rachis triangular, channelled adaxially, convex abaxially, sparsely puncticulate; lamina undivided, inversely sagittate, bifid, to 115 cm long, 35 cm wide, lobe to 35 cm long, pinnately ribbed and distinctly plicate, up to 25 major costae

facing page
1. *Heterospathe califrons* Fernando. **A** habit × 1/15; **B** leaf sheath and basal portion of petiole × 1; **C** distal portion of petiole and basal lamina × 1; **D** apical portion of lamina × 7/8; **E** young inflorescence and prophyll ×1; **F** portion of rachilla × 2.5; G staminate flower × 12; **H** staminate flower showing stamens and pistillode × 12; **I** pistillate flower ×11; **J** sepal of pistillate flower × 10; **K** petal of pistillate flower × 11; **L** pistil × 11; **M** infructescence × 1; **N** fruit × 3.5; **O** seed × 3; **P** vertical section of seed × 3. **A–L** from *Fernando 1567 & Sotalbo,* **M–P** from *Fernando 1575.* Drawn by F.B. Samiano.


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2 (top left). *Heterospathe califrons* in rather open forest. 3 (top right). *H. califrons*: inflorescence in bud. 4 (bottom left). *H. califrons*: inflorescence at staminate anthesis. 5 (bottom right). *H. califrons*: infructescence with ripening and ripe fruit. All photos: E.S. Fernando.



6. *Heterospathe califrons* growing with *Areca costulata* in forest on ultramafic rocks, Diwata Mountains, Mindanao. Photo: E.S. Fernando.

(ribs) on each side of the rachis, the abaxial surface drying glaucescent; indumentum on midrib red-brown scurfy. *Inflorescence* interfoliar (Figs. 3, 4), erect, becoming only slightly curved in fruit, to 85 cm long, branching to 2 orders; peduncle ca. 57 cm, covered with brown scales; prophyll lanceolate, ca. 20–35 × 2.0–2.5 cm, persistent, attached near the base and completely encircling the peduncle, tubular, 2-keeled laterally, and splitting abaxially and apically; peduncular bract attached below middle of peduncle, to ca. 37 × 2.4 cm, splitting abaxially, marcescent as the inflorescence matures; 1 or 2 basal first-order branches of rachis further branching with 2 rachillae, distal branches as rachillae, ca. 10–12, arranged spirally along axis, each ca. 0.2 × 5–13 cm, more or less terete or slightly angular, tapering distally, covered with brown scales as peduncle; triads or very rarely paired flowers borne spirally along the rachilla and subtended by low, lip-like bracts. *Staminate* flower oblong, light yellowish, ca. 2 × 4 mm; sepals 3, petals 3, longer than the sepals; stamens 6, filaments white; pistillode prominent, conical. *Pistillate* flower rounded in bud, greenish-yellow, shorter than the staminate flower, ca. 1.5 × 2 mm; sepals 3, imbricate, ciliolate along the margins, ca. 1.2 × 1.5 mm; petals 3, imbricate at base, broadly acute at tips, ca. 1 × 1.5 mm; pistil ovoid-conical, ca. 0.8 × 1.2 mm, staminodes minute. *Infructescence* (Fig. 5) with erect to slightly arching rachillae. *Fruits* spirally arranged along the rachilla, glossy green, ripening yellow then red, oblong-ovoid, 16 × 7 mm, stigmatic residue obliquely apical, pericarp thin, fibrous, epicarp peeling off readily and drying granulose with sclerosomes. Seed ovoid, ca. 15 × 8 mm, with prominent hilum, endosperm ruminate; embryo basal. Germination adjacent-ligular; eophyll bifid.

DISTRIBUTION AND HABITAT: PHILIPPINES. N.E. Mindanao: eastern slopes of the Diwata Mountains, in forest on ultramafic rocks, with canopy to 20 m, often along small creeks and partially water-logged areas; ca. 580 m alt. Endemic.

SPECIMENS EXAMINED: PHILIPPINES. Mindanao Island, Surigao del Sur Prov., Carmen, *Fernando 1565* (LBC); *Fernando 1567 & Sotalbo* (holotype

LBC; isotypes BH, K, PUH); *Fernando 1568 & Co* (LBC), *Fernando 1570* (LBC), *Fernando 1575* (K, LBC); *Co 4932* (PUH), *Sotalbo 1123* (PUH).

VERNACULAR NAME: *Yanisi* (Manobo).

The entire or undivided, bifid leaf is rarely known in the genus (Uhl & Dransfield 1987), except very rarely, in *Heterospathe scitula* Fernando from Luzon Island (Fernando 1990b). In its undergrowth habit and erect, undivided, and bifid leaves, it looks very similar to *Asterogyne martiana* (H. Wendl.) H. Wendl. ex Hemsley from Costa Rica. The solitary, short-stemmed habit, and persistent leaf sheaths and petioles are also reminiscent of *Heterospathe brevicaulis* Fernando from Luzon Island (Fernando 1990b) growing on similar habitats.

Heterospathe califrons was found growing with another arecoid palm, the stilt-rooted *Areca costulata* Becc. (hitherto unrecorded for Mindanao Island) (Fig. 6), and other plants such as large clumps of the sedge *Mapania palustris* (Hassk. ex Steud.) F.-Vill. [Cyperaceae], the rattan *Calamus aidae* Fernando, *Pandanus copelandii* Merr., *Sararanga philippinensis* Merr. [Pandanaceae], *Tristaniopsis micrantha* (Merr.) P.G. Wilson & J. T. Waterhouse [Myrtaceae] and the pitcher plants *Nepenthes merrilliana* Macfarl. and *Nepenthes truncata* Macfarl. [Nepenthaceae]. *Heterospathe califrons* appears to be restricted to ultramafic habitats and has not been observed elsewhere in adjacent forests of other types. It prefers areas that are partially water-logged or near small creeks. Only a small population exists in the type locality, and the area urgently needs to be adequately protected. Although four other species of *Heterospathe* [viz. *H. elata* Scheff., *H. elmeri* Becc., *H. intermedia* (Becc.) Fernando and *H. philippinensis* (Becc.) Becc.] are known from Mindanao or nearby smaller islands, these are not known to occur in ultramafic habitats and have not been observed in association with *H. califrons*.

Heterospathe califrons has great potential as an ornamental plant and, undoubtedly, is one of the most beautiful endemic palms of the Philippine Islands.

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Notes on the Genus *Ammandra* (Palmae)

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1. *Amandra decasperma* in secondary forest at the Magdalena river valley.

The genus *Ammandra* is recorded from the inter-Andean valley of the Magdalena river in Colombia. The new finding supports the inclusion of *A. dasyneura*, from the northwestern Amazon of Colombia and Ecuador, under *A. decasperma*, from the Pacific lowlands of Colombia.

The genus *Ammandra* was described by Cook (1927), based on a specimen collected by himself near Buenaventura, on the Pacific coast of Colombia. The genus is a member of the strange subfamily Phytelephantoideae, the vegetable ivory palms, and differs from *Phytelephas* mainly in its staminate flowers, which have a well-developed receptacle that is the most conspicuous part of the flower, and small stamens scattered all around its outer surface. The stamens are numerous, and look like sand grains dusted over the prismatic receptacle. The name *Ammandra* alludes to this character: it is composed of the Greek roots *ammos* (sand) and *andros* (man, in reference to the stamens).

Ammandra decasperma, the species described by Cook, remained as the only member of the genus until a second species, from Amazonian Ecuador, was described by Balslev and Henderson (1987) as *Ammandra natalia*, a name honoring Natalie Uhl. This species differs from *A. decasperma* in many respects, particularly its larger size, erect stem up to 5 m tall, long inflorescences, and staminate flowers with rounded receptacle and long stamens.

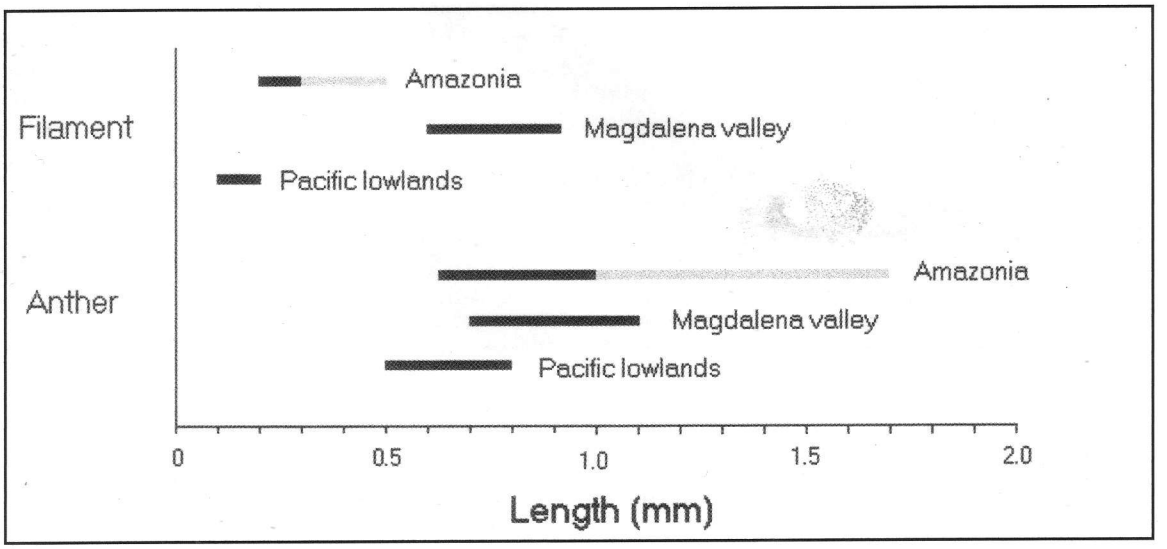
Shortly after the discovery of *Ammandra natalia*, Barfod (1991) published his monograph of the subfamily Phytelephantoideae. In this work there were two significant changes concerning the genus *Ammandra*: first, *A. natalia* was transferred to a genus on its own, *Aphandra*, separated from *Ammandra* by its staminate flowers with an elongated receptacle that forms a pseudopedicel; and second, *Phytelephas dasyneura*, a species described by Burret (1930), was shown to belong in *Ammandra*, and was accordingly named *Ammandra dasyneura*.

According to Barfod, *Ammandra dasyneura* differs from *A. decasperma* mainly in the larger number of stamens (800–1200 vs. 300–500), with longer filaments (0.5 vs. 0.1–0.2 mm) and longer anthers (1–1.7 vs. 0.5 mm). These differences, faint as they might seem, were reinforced by the isolation of both species on either side of the Andes. *Ammandra decasperma* was known only from the Pacific lowlands of Colombia, west of the Andes, whereas *A. dasyneura* was known from the northwestern Amazon in Colombia and Ecuador, east of the Andes. No populations of this genus had been found in the inter-Andean valleys in between.

During recent field work in central Colombia, we found a population of *Ammandra* in the wet middle valley of the Magdalena river (Fig. 1). As this valley lies deep between the Central and Eastern Andean cordilleras, in an area intermediate between the ranges of *A. dasyneura* and *A. decasperma*, the finding was particularly interesting. Thus, we have reassessed the differences between the two species, under the light of the new discovery.

The populations of *Ammandra* from the Magdalena river valley are vegetatively similar to both *A. decasperma* and *A. dasyneura*, which are themselves undistinguishable in habit or foliage. Counts of the number of stamens of the new population gave a figure filling the gap between

2. Length of filament and anther in populations of *Ammandra decasperma* from both sides of the Andes and from the inter-Andean valley of the Magdalena river. Dark lines correspond to specimens examined by us (cited in the text); light line corresponds to measurements cited by Barfod (1991).



A. dasyneura and *A. decasperma*, 440–1321 stamens per flower. Measurement of anthers and comparison with those of specimens of *A. dasyneura* (*Bernal & Galeano 1411*, *Balslev 62070*) and *A decasperma* (*Bernal et al. 1073*) at the National Colombian Herbarium, COL, showed that the ranges of anther length mostly overlap, whereas there is a continuum in filament length (Fig. 2). Interestingly, the length of the filament in the new population is not intermediate between those of *A dasyneura* and *A decasperma*, but it is slightly larger. The difference, however, is small and it could hardly be used as an argument to keep two separate species or subspecies or, even less, to recognize a third species. On the contrary, our study of the specimens has shown that there is variability in anther size within each purported species, particularly *A. dasyneura*. Thus, for example, the specimen *Bernal & Galeano 1411* from Colombia has shorter anthers than *Balslev 62070* from Ecuador (0.6–0.8 vs. 1.0 mm), and the first figures are lower than the range given by Barfod (1.0–1.7 mm).

Thus, the finding of the new population in the Magdalena river valley indicates that *Ammandra decasperma* is better regarded as a species with its distribution range separated by the Andean mountains into three isolated units. This is particularly interesting in biogeographical terms, as the seeds of *Ammandra*, dispersed by rodents (Barfod 1991), are not suited for long distance dispersal. Thus, the currently isolated populations are probably the result of a former wider distribution fragmented by the Andean upheaval (Barfod 1991). Since the upper Magdalena valley became isolated from the Amazonian lowlands by the late middle Pliocene (ca. 3.6 million years ago) (Hoorn et al. 1995), it is intriguing that palms in the three areas have diverged so little. A possible explanation for this is that the populations east of the Andes may have had intermittent contact with those from the Magdalena river valley across the lower passes of the Andes (e. g. the one at 3° 18′ N, which is now at ca.1700 m over sea level) during the warmer interglacial periods of the Quaternary, when suitable ecological conditions for *Ammandra* may have been found at higher elevations than they are today. Thus, for example, during the last interglacial that probably started about 130,000 years ago, the climate on the Eastern Cordillera seems to have been slightly warmer than it is today (van der Hammen 1974). Populations of *Ammandra* from the Magdalena river valley, in turn, may have been in contact with those from the Pacific (or may even have migrated there) around the northern end of the Central and Western Cordilleras, as are still today many species of plants and animals. However, no populations of *Ammandra* have been found in that area, although it has been well explored for palms (Galeano & Bernal 1987). Another possibility for the scarce diversification of the isolated populations is that evolution in this group proceeds at a low rate.

Ammandra decasperma O. F. Cook, J. Wash. Acad. Sci. 17: 218. 1927. Type: Colombia. Valle del Cauca: Buenaventura, 26 May 1926, *Cook and Baker 153* (holotype, US, n.v.).

Phytelephas decasperma (O. F. Cook) Dahlgren, Field Mus. Nat. Hist., Bot. Ser. 14: 231. 1936.

Phytelephas dasyneura Burret, Notizbl. Bot. Gart. Berlin-Dahlem 11: 5. 1930. Type. Colombia. Caquetá: Getuchá, Río Orteguaza, 30 Jul 1926 *Woronow & Juzepczuk 6335* (holotype B, destroyed; lectotype (Barfod 1991), LE, n.v.).

Ammandra dasyneura (Burret) Barfod, Opera Botanica 105: 43. 1991.

Solitary or clustered dioecious palm, with stems short and subterranean, or prostrate and up to 1.5 m long and 25–35 cm in diameter, usually decaying at the older portions. Leaves 8–20 erect or arching; sheath 1–1.7 m long, strongly fibrous, most of it appearing like the petiole; petiole cylindrical, 1–2.4 m long, 2–2.5 cm in diameter, green; rachis 3.3–4 m long, with 40–62 pinnae; middle pinnae opposite, to 85 cm long and 5 cm wide, glabrous, with a prominent submarginal vein on either side of the midvein. Inflorescences interfoliar, the staminate up to 1.4 m long; peduncle 30–75 cm; peduncular bract 35–50 cm long; rachis 30–92 cm long; rachillae 45–90, each with 6–9 flowers 0.5–3 cm long, the proximal ones larger and with more stamens; perianth obscure, hidden by the enlarged receptacle, the latter making the most conspicuous part of the flower; receptacle prismatic, to 1.5 cm long, with a small, central pistillode; stamens 300–1321; filaments 0.1–0.9 mm long; anthers 0.5–1.7 mm long. Pistillate inflorescence with peduncle to 30 cm long; peduncular bract 15–30 cm long; pistillate flowers 6–10 densely arranged in a head on a short rachis 1–2.5 cm long, each flower up to 25 cm long, with 7–10 narrow tepals to 10 cm long; ovary with 6–10 locules; style to 7 cm long; stigmas to 5 cm long. Infructescence 20–25 cm diameter, with 3–10 fruits. Fruit depressed-globose, 10–12 cm diameter, with woody spiny projections to 1 cm long; seeds 6–10, wedge-shaped, with two flat sides, the distal surface convex, 4.5–5 cm long, 3–4 cm wide, 2.2–3 cm along the tangential face. (Figs. 1, 3, 4).





3 (left). *Amandra decasperma*, habit. 4 (right). *Amandra decasperma*, Detail of the staminate inflorescence.

SPECIMENS EXAMINED (only those from the new locality are cited). COLOMBIA. Boyacá: Municipio de Puerto Boyacá, Puerto Pinzón, on río Ermitaño, 6° 03′ N, 74° 14′ W, 450 m, Jan 2000, *Ramírez & Morales s.n.* (COL); 2 Nov 2000, *Bernal et al. 2506* (COL, HUA, NY), *2507* (COL, HUA).

At the Magdalena river valley, *Ammandra decasperma* is apparently restricted to a small area at the northern foothills of the Serranía de las Quinchas, a small mountain range of the Eastern Cordillera of the Andes. At this area, the species is abundant in primary and secondary wet forest, with a density of 540 and 297 adult palms per ha in disturbed primary forest and secondary forest, respectively. As in other areas of its range, at this locality *Ammandra* grows also on hilly terrain. Flowering takes place throughout the year, but peaks between June and August (G. Ramírez & I. Morales, unpublished data).

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Leaflet by Leaflet – Painting the Palms of North Queensland

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1. *Oraniopsis appendiculata* growing on the mossy bank of a crystal-clear creek at high altitude, on Mount Lewis.

In 1997, Lucy Smith embarked on a two-year Master of Creative Arts degree in illustration, designed to research and portray in detail the palm flora of North Queensland. The resulting collection of paintings captures eighteen of these palms in their natural habitats and forms, highlighting the diversity and beauty of both the palms and the environments in which they grow.

Images of palms in Australian art history

The palms of Australia were painted and drawn for many purposes in the last two centuries. They appear in drawings for the description of new species, as elements in the painted landscape, and are also mentioned in the accounts of European exploration and settlement of the country.

The palms that were most often mentioned and illustrated by early European explorers and settlers in Australia, from the 18th century onwards, were from the genera *Livistona*, *Archontophoenix* and *Ptychosperma*. Beginning with Joseph Banks' first observations of the Australian vegetation in 1788 (in fact the only plant to which he could attribute a name), many accounts by early settlers and explorers contained references to the "cabbage palm." The cabbage palm in question, *Livistona australis,* indeed once grew quite extensively around Botany Bay, site of the first European landing, and Sydney Harbor, site of the first fleets of settlers. Those people keeping accounts of settlement were mostly interested in the palms' immediate and potential practical uses in providing food and construction material.

For a short time in Sydney harbor (then known as Port Jackson), in the absence of other suitable wood for construction, the trunks of felled *Livistona australis* were used to make temporary but basic shelters. However, this 'wood' did not last for longer than one or two wet summers before rotting away. Many palms were also felled and the 'cabbages' or growing tips eaten. Unfortunately the effect on the Sydney harbor palm population from this use was drastic. Barron Field, writing in 1825 noted that the palm trees which had "once . . . characterized the neighborhood of Port Jackson . . . have long been exhausted," and that "the absence of these trees has taken away much from the tropical character of Sydney." *Livistona australis* and *Archontophoenix cunninghamiana* can still be found in the temperate rainforest of the Illawarra district, south of Sydney. In the 19th century, visiting landscape artists. Eugene Von Gerard, Conrad Martens and John Skinner Prout included them in their romantic paintings of rainforest landscapes and scenes of bush settlement. Eugene Von Gerard in particular drew these palms with great accuracy.

Australian palms were also illustrated from the early 19th century for scientific purposes. In 1802 Ferdinand Bauer made the first comprehensive, scientific illustration of an Australian palm when he

My initiation into the world of palms came with a project for the Townsville Palmetum in 1995. Under the guidance of local palm botanist John Dowe, I explored twelve species of locally growing palms and painted them in watercolor to hang as informative pieces for the visiting public. Since then, I was employed from time to time by John to make scientific pen and ink drawings of new species of palms from Australia, Vanuatu, and Papua New Guinea. The prospect of a larger project that enabled me to go further into my subject than in previous projects, held a lot of appeal. I decided to paint as many species of palms from the north Queensland region as possible, using detailed observation and information not previously explored.

The native palm flora of Australia is so rich and diverse that the hardest task was to narrow my subject matter down. I did this by defining a palm-rich area and listing the number of species growing within its boundaries. I eventually arrived at a figure of around 35 species, which included representatives of nearly all of the 19 genera in the Australian palm flora. This area ran from the Burdekin River in the south, east to the north Queensland coast, to the tip of Cape York Peninsula in the north, and west to the edges of the Wet Tropics Region. Within this region I found not only an interesting range of species and forms, but also an even more interesting selection of environments, which ranged from seasonally flooded rivers and savannah plains, coastal forest, lowland woodland and rainforest, and high altitude woodland and rainforest.

After familiarizing myself with as many species planted locally as possible, and reading up on the relevant scientific literature, I planned the most important part of the research – the field work, during which I would endeavor to visit every species of north Queensland palm in the wild. The first, shorter trips were made to Mission Beach, Cairns and Paluma. In the palm-dense Mission Beach region, I shot many rolls of film in the extensive stand of *Licuala ramsayi* just inland from the coast. On the beachfront, large *Arenga australasica,* with leaves up to three metres long, proved difficult to photograph, surrounded as they were by dense vine forest, fringing the coastal sands. Graceful specimens of *Ptychosperma elegans* grew in the nearby slopes of the coastal ranges.

Into the far northern reaches of the Wet Tropics area, I made the muddy ascent up Mount Lewis in my trusty four-wheel-drive in an attempt to

drew, and later painted in watercolor, *Livistona inermis*, then incorrectly identified as *Livistona humilis*. The original drawing was most likely made from a specimen collected from an island in the Gulf of Carpentaria, and described by scientist Robert Brown. Both Brown and Bauer were taking part in Matthew Flinders' voyage of 1801–1803, whose successful mission saw the circumnavigation of the continent and the extensive collection of flora and fauna for scientific analysis and classification. Other scientific drawings were made for the description of new species, for example *Linospadix monostachya* [Von Martius' *Historia naturalis palmarum* (1837)], and *Livistona australis* [Curtis' Botanical Magazine (1857)]. Walter H. Fitch executed the color lithographs of *Livistona australis* for Curtis' Botanical Magazine from a specimen successfully grown at Kew. Specimens of *Livistona australis* grown from early collections of seeds can still be found today in most European botanical gardens

Expedition artists recorded palms whilst taking part in exploration by both sea and land. In 1848, Oswald W. Brierly, expedition artist on the voyage of the HMS Rattlesnake, made a revealing entry in his ship's diary. It tells of how a rare grove of mature, fruiting coconut palms had been discovered by the ship's crew on one of the Frankland Islands, south of Cairns. Brierly noted his surprize in finding such a grove of mature trees, the first to be found during many years of exploration of the coast and islands. This unpublished artistic record, which includes an illustration and written description, places the earliest recorded date for a known population of mature, wild-growing coconut palms in Australia back to 1848.

In other accounts, populations of wild palms were described with reactions varying from awe and admiration, to frustration. Engravings illustrating Huxley's 1852 account of the Edmund Kennedy expedition entitled "Cutting Through The Scrub" depict the thorny stems of *Calamus* species blocking the way of men with horses who are attempting to traverse the dense lowland rainforest near Tully. The illustration does not really depict the true denseness of *Calamus australis* and *Calamus moti* (Fig. 4) thickets occurring in the lowland rainforest of the area, now largely cleared for agriculture. These palms were specifically mentioned as a major source of delays for the expedition which began in 1848, and was subsequently disastrous when all but three men perished due to the unforeseen difficulties of traversing the rugged north Queensland landscape.

photograph *Oraniopsis appendiculata* (Fig. 1) and *Archontophoenix purpurea* (Fig. 2), the latter being a species endemic to one small area on the mountain. I had previously visited the area with John Dowe during the collection of a new species, *Linospadix apetiolata*, and knew it to be a fickle place as far as rainy weather and sunlight were concerned. Sure enough, the mist was thick and the rain unrelenting but our patience was rewarded when, in sight of a stand of *Archontophoenix purpurea*, the clouds cleared momentarily. For a brief few minutes I was rewarded with the sight of shafts of sunlight reaching through the mist and illuminating the beautiful palms, framed by wild gingers, ferns, and massive vine-laden trunks.

On each visit to the rainforest I was always in awe of my first sight and impression of a new palm species, such as the giant *Oraniopsis appendiculata* on Mount Bartle Frere, or the diminutive and elegant *Linospadix monostachya* growing nearby in the understorey. Away from the rainforest habitats, it was always a contrast to see some species of *Livistona* growing in quite different conditions. *Livistona lanuginosa*, the western-most palm included, had by far the most hostile environment to contend with. They grow in isolated patches on the banks of tributaries of the Burdekin River, which can remain completely dry for long periods of time. The stand that I saw at the Cape River in the height of the dry season was hit with floods of over three meters height some six months later, when heavy rains flooded the area during a cyclone. In more lush woodland surroundings on the edge of the rainforest grew *Livistona australis* (Fig. 3), a distinctive form of the most widespread Australian palm species, found in the Bluewater and Paluma Ranges. In the disturbed rain forest of the wetter regions of these ranges, thickets of *Calamus moti* (Fig. 4) and *C. australis* grew in profusion.

In September 1997 I made a major field trip to the Cape York Peninsula, assisted by funding from the Palm and Cycad Societies of Australia. Accompanied by John Dowe, whose knowledge of the palm areas was extensive, and field assistant Gavin Smith, I spent nearly three weeks travelling

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2. *Archontophoenix purpurea* is one of two species endemic to Mount Lewis, where mist and rain almost continually shroud the vegetation, and chance breaks in the cloud provide sudden, dramatic illumination.





some 7,000 kilometres, much of this in four-wheel drive. In the Lockerbie Scrub, a small area of rainforest at the tip of Cape York, we saw Papua New Guinea species *Calamus hollrungii, Calamus aruensis* and giant *Gulubia costata* soaring above pandanus swamps. Once, while photographing *Hydriastele wendlandiana*, John Dowe's curiosity got the better of him and he accidentally disturbed a nest of angry golden wasps – twice! We waited in fear for an allergic reaction to our scores of stings from this extremely territorial wasp (they stop their attack abruptly at a distance of 20 meters from the next), but fortunately were able to continue relatively unfazed!

Moving southwards down the Peninsula, I saw great stands of spiky-trunked *Livistona benthamii* surrounded by *Melaleuca sp.* trees, and *L. muelleri* growing amongst the eucalypts and termite mounds so typical of the Peninsula. Some of the *L. muelleri* trunks and lower leaves were still smouldering from recent bushfires. We ventured east into the isolated rainforest of the Iron Range and found the graceful *Archontophoenix tuckeri*, named for Robert Tucker, growing on the rocky creek banks of steeply-walled valleys, surrounded by tall forest trees and lianas, native bamboo and pandanus. We surprised a cassowary on a deserted stretch of the creek, and it promptly took off into the rainforest, Gavin and John in hot pursuit. I chose to wait back at the creek and was photographing a nice fruiting specimen of *Archontophoenix tuckeri* when a gentle 'plink' made me turn around, just in time to see the cassowary creeping quietly back across the water. Although I must give equal praise to the charms of all my palms, I would have to say that seeing the foxtail palms, *Wodyetia bifurcata,* growing in their natural habitat, was one of the highlights of the Cape York trip. After a full day's slow, tortuous driving towards the coast and a pleasant walk, we finally reached the foxtail site. I was struck by the sight of thousands of these magnificent palms sprouting from every possible piece of ground amongst the huge granite boulders, which covered the hills of Cape Melville. It was a true delight to climb amongst the palms, scrambling over and under boulders, while I studied the crowns of mature giants at head-height from the tops of the rocks.

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3. *Livistona australis* This distinctive specimen found on the Paluma Range grows amongst striking *Eucalyptus grandis* and *Casuarina* spp. on the margins of the surrounding rainforest. This specimen and those from the nearby Bluewater Range population may represent a local variey of the widely distributed species.

On the way back from Cape Melville, crossing the flat savannah plains of Lakefield National Park, we saw fabulous stands of massive *Corypha utan* (Fig. 5).

When the field trips were more or less completed, I began the task of creating the illustrations. First I had to sort through the hundreds of photographs I had taken, arranging many of them into large panoramas which covered the walls of my studio. I studied these, along with my field notes and sketches, until I found the best specimens in the most typical surroundings. Then I made several small composition sketches, and once I was happy with one I enlarged this concept into a drawing. Drawing an entire palm is like cracking a structural code. Firstly you need to work out how the leaves are built and then how they emerge and held from the central part of the "trunk." The arrangement of leaf base remains on a broad *Livistona* trunk will tell you a lot about the spiralling growth patterns formed by the leaves. Then of course you must understand the overall look and feel of the palm. At what angle are the leaves held, and how are they spaced? Do the leaflets, or segments, droop elegantly or are they held erect? From where do the inflorescences emerge – are they produced amongst the leaves or do they hang clearly below the flat expanse of the tubular crownshaft?

Painting the palms was the next, and final, step. Each drawing was worked on for several days until all the detail that I would require to paint was included. As well as understanding palm structure, when painting palms there are plenty of challenges to your color mixing skills. Faced with a sea of greens, it is amazing just how many types of green you can differentiate by looking at them with a painter's eye. In the north Queensland palms I found a surprizing array of greens, ranging from the subtle, pale blue-green of *Livistona lanuginosa* to the darker, ultramarine green of *Ptychosperma elegans*. Trunks, too, can be many different colors, especially those with fire-blackened bases.

After all that painstaking preparation, the actual painting of the palms was an enjoyable experience! The drawings were checked for accuracy by John Dowe, then traced onto illustration board where the painting would be executed. For up to three weeks I huddled over each painting, carefully building up details using tiny sable brushes. I had first laid down the backgrounds using an airbrush or a large watercolor wash brush. I painted the palms first with a layer of thin watercolor over the drawing, and then slowly built this up by applying layers of opaque gouache paint. Each background needed to have its own special

character that expressed the nature of a particular piece of forest. It was enjoyable to draw on my vivid memories of visiting each palm – I learned to recall an early misty morning at Paluma seeing *Laccospadix australasica*, and that icy, accidental plunge from a luxuriously mossy rock, into the crystal Mount Lewis stream which ran past stately *Oraniopsis appendiculata*. When not daydreaming, I carefully counted yet again every leaflet, and observed the particular way in which they hung in space. Finally after a couple of weeks, the day would come when I could declare a painting to be "finished."

By February 1999 I had painted 18 species in habitat, and a small group of flower and fruit pieces. I was almost ready for the March exhibition. All of the work was framed, including a selection of working drawings, which were hung alongside the finished paintings. On 9th March 1999, the "Palms of North Queensland" exhibition opened at the Pinnacles Gallery, Townsville to a warm and receptive audience. From the comments of visitors throughout the ten-day duration of the exhibition, I learned about the varied responses to the work from a wide cross-section of people. Many people expressed their surprize at the variety and number of local native palms that existed, some of which could be found growing in their gardens and streets. Others remarked on the variety of environments portrayed, and felt that the illustrations provided them not only with a tour of the local native palm flora, but also of their surrounding natural countryside. Judging from these responses, I felt that the exhibition was a success. Each illustration had achieved its aim, to portray each species of palm accurately in structure, form, and natural appearance. Since the exhibition, I have looked at the possibilities of expanding the project to cover even more species of Australian palms, and perhaps to produce an informative book using the illustrations. Four of the paintings, which represent a good cross-section of the work, have since been reproduced in a limited edition of hand-signed, archival quality prints. The originals are tucked away, waiting for their next public appearance.

My story now switches suddenly to the other side of the world. The setting is the Palm Room in the Herbarium at the Royal Botanic Gardens, Kew, London. In another time, another place, I find myself drawing species of New Guinea palms of all descriptions; rattans from Africa, new *Licuala* species from the rainforests of Borneo, all this from the relative comfort of my window-side desk. As I pull each dried and pressed specimen from its tagged and numbered box, I close my eyes and try hard to imagine the palm from which this leaf was cut, wrapped, and then placed between the boards of a plant press in some distant tropical forest. I picture it growing in its natural setting, reaching high into the canopy for the light, or sitting quietly in the gloomy understorey, passively gathering leaf litter. In my diagnostic line drawings I attempt to convey my new found, and ever growing, understanding of these plants to assist in my job of illustrating the great diversity of the world's palm flora. My urge to return to the forests and woodlands, nonetheless, has by no means diminished, and I find myself drifting off into daydreams of painting green palms, and more palms.

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4 (page 134). *Calamus moti* growing in a typically dense thicket in a section of disturbed rainforest, its leaves forming a harmonious pattern of graceful arches and interwoven lines. 5 (page 135) *Corypha utan* from the hot Lakefield savannah showing three different growth stages, including the terminal flowering that precedes the death of the massive, mature plant.

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Establishment of *Babassu* in Pastures in Pará, Brazil

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***Attalea speciosa, babassu*, occurs in savannahs in the dry regions of northern Brazil and in dense humid forests in the state of Pará. Its proliferation is favored by agriculture, and its invasion of pasture may even cause abandoning of the land. The success of this species is partly due to the negative geotropism of its terminal bud in the early stage of development, which offers the plant protection against fire.**

The *babassu* palm, *Attalea speciosa* Mart. ex Spreng., belongs to the cocoid subtribe Attaleinae. The palm has had a complex nomenclatural history and was until recently known as *Orbignya phalerata* Mart. with the following synonyms: *Orbignya martiana* Barb. Rodr., *Orbignya speciosa* (Mart.) Barb. Rodr., *Orbignya barbosiana* Burret, *Orbignya macropetala* Burret and *Attalea speciosa* Mart. (Anderson & Balick 1988, Anderson et al. 1991, Glassman 1999). Now the four very closely related genera *Attalea*, *Maximiliana*, *Orbignya* and *Scheelea* have been merged with *Attalea,* and *babassu* is correctly named *Attalea speciosa* Mart. ex Spreng. (Henderson 1995, Henderson et al. 1995, Uhl & Dransfield 1999, Lorenzi 2000).

Babassu occurs in the Amazonian region (Anderson & Balick 1988) in both humid dense forests and savannas (Uhl & Dransfield 1987). In the first stage of development (29 to 38 years), it is acaulescent (Anderson 1983). The stem, once erect, can reach up to 30 m in height, but retains a subterranean part (Uhl & Dransfield 1987). The infructescences may contain up to 300 fruits (Molion 1992). Each fruit has 1–7 seeds and is characterized by a thin to thick epicarp, very hard and fibrous or a sometimes pulpy mesocarp and a thin or usually very thick, hard and bony endocarp (Uhl & Dransfield 1987). Germination is remote-tubular and cryptogeal (Anderson 1983); the terminal meristem has negative geotropism in the first stage of development (Uhl & Dransfield 1987, Anderson & Anderson 1985, May et al. 1985a, b), and shows a specific seedling mechanism known as "saxophone" axis (Tomlinson 1979, 1990).

In primary forests the density of adult palms is low (Anderson & May 1985, Peters et al. 1989, Barbosa and others pers. com.) in contrast to the high seedling density (Kahn & Granville 1992). The origin of *babassu* in primary forest is not certain. Ther are two hypotheses.The *babassu* could be a naturally occurring species in the primary forests and, in fact, does complete its life cycle in this environ-ment (Anderson et al. 1991, Anderson 1983). It is also possible that *babassu* was introduced by Indian populations, and the fact that it occurs in considerable densities in ancient inhabited zones supports this idea (Balée 1988). Neither of the two hypotheses can be excluded with current knowledge. However, we can say that man encouraged the establishment or proliferation of *babassu* by opening clearings or

cutting the forest without necessarily planting the palm. In this way *babassu* could have have increased its distribution and density.

The distribution of *A. speciosa* in Brazil occurs in an area of about 200,000 km^2 (May et al. 1985b), most of it (78%) concentrated in the states of Maranhão, Piauí and Goiás but it also occurs in the states of Ceará, Pará, Amazonas, Mato Grosso and Minas Gerais (Anderson 1983). In regions with a long history of human settlement, the area occupied by secondary vegetation is dominated by the *babassu* palm, as in the state of Maranhão, where one-third of its area shows evidence of this type of vegetation. In this region *babassu* is used extensively (Anderson & May 1985, May et al.1985b, Anderson et al. 1991, IBGE 1983, Wilhelms 1968). In the eighties, trade in *babassu* products may have increased the income of about 450,000 poor farming families, involving about 2 million people (May et al. 1985a, Balik 1987). In spite of a law in Maranhão, which forbids the cutting of *babassu*, the current tendency is towards the expansion of pasture land resulting in reduced *babassu* density (May et al. 1985a).

Other states were populated more recently by colonists from various regions of Brazil, e.g., in the state of Pará in the region near Marabá. Here the *babassu* palm occurs only in certain areas and there is no traditional use. With a shorter dry season and increased rainfall, the climatic conditions are generally less drastic in Pará than in Maranhão. Furthermore, the farmers do not collect the *babassu* fruits. Thus one can expect a different population dynamic of this palm in the pastures of Pará. *Babassu* is used currently in the region of Marabá by certain agriculturists only to provide shade for cattle. While trade in *babassu* products provides a very low profit, it permits the survival of numerous very poor families without land in Maranhão, but the income is too low to attract the attention of small farmers in Pará. For them the installation of pastures constitutes a more profitable option in the short-term.

This study had as its objective the determination of factors favoring or negatively affecting the establishment of *babassu* formations in the region of Marabá, where we observed that the fruits after dispersal may be exposed to extreme sun conditions, fire and sometimes buried by animals. Field observations on seed number per fruit, dispersal and regeneration of this palm were done under the specific conditions in Amazonian pastures in Marabá. Experimental germination studies were done to accompany the field observations, simulating different environmental conditions and quantifying the effect of sun exposure, shade, fire and burial.

Methods

Study sites

The study was carried out in the Amazon region of Brazil. The field studies were conducted in Pauseco, a settlement made up of a small group of families about 30 km north of the town of Marabá, in the south of the state of Pará. The seed germination studies were done on the campus of Instituto Nacional of Pesquisas da Amazônia (INPA), in Manaus, state of Amazonas. In Marabá, pasture follows a culture of rice/maize/manioc, which is temporarily established after the clearing of the rainforest. The pastures are generally planted with *Panicum maximum* or with *Brachiaria brizantha*. Every year in August-September, fires raze a large part of the pasture land. The practices of landowners have consequences for the landscape in Marabá. Three types of pastures are found around Marabá. The first belongs to large farms, in which *Attalea speciosa* is not present. The adult palms had been cut and the young ones were treated with herbicides as soon as they appeared. In the second type the pastures, belonging to small farmers also not interested in the use of *babassu* but with no access to herbicides, the pastures are very quickly invaded by this palm, but as soon as the land is dominated by *babassu* it is abandoned. The third type belongs to small but more prosperous agriculturists who allow a moderate number of *babassu* in their pastures in order to provide shade for their cattle. We conducted our studies in this type of pasture.

Field study

The field studies were conducted during May 1998 on selected *babassu* palms in pastures dominated by *Brachiaria brizantha*. The infructescences from three *babassu* palms (Palm 1, 2 and 3) were harvested and all fruits were cut to count the number of seeds.

Regeneration studies were carried out on other three adult *babassu* palms (Palm 4, 5 and 6). Palm 4 had its trunk still covered by leaf bases but carried three infructescences with immature fruits and showed traces of four prior infructescences. Palm 5 with a stem of 2.5 m heigh, had one infructescence with immature fruits and traces of four prior infructescences. Palm 6 with a stem of 2.5 m heigh had three infructescences with immature fruits and traces of nine prior infructescences (Figure 1).

All fruits, seedlings and young plants within a radius of 0–2 and 2–5 m, (covering an area of 12.6 m^2

Table 1: Number of seeds per fruit of six selected adult palms of *Attalea speciosa* individually examined.

		Palm 1 *	Palm 2 *	Palm 3 *	Palm 4 +	Palm 5 +	Palm 6 +	Total
	n =	62	83	86	51	43	173	498
Fruits with 1 seed (%)		3.2	0.0	23.3	31.4	18.6	10.4	12.9
Fruits with 2 seeds (%)		35.5	20.5	41.9	33.3	39.5	32.4	33.1
Fruits with 3 seeds (%)		61.3	65.1	34.9	35.3	41.9	41.6	46.2
Fruits with 4 seeds (%)		0.0	14.5	0.0	0.0	0.0	15.6	7.3

* fruits of a single infructescence.

\+ all germinated fruits beneath the palm as well as 30 ungerminated fruits.

Table 2: Burial conditions of germinated *Attalea speciosa* fruits beneath three adult palms (Palm 4, 5 and 6).

Position of fruits		Palm 4	Palm 5	Palm 6	Total
	n =	21	13	143	177
Above soil	(%)	19.0	15.4	9.8	11.3
Partly buried	(%)	66.7	69.2	6.3	18.1
Completely buried	(%)	14.3	15.4	83.9	70.6

Table 3: Quantification (in %) of seeds germinated per fruit of three *Attalea speciosa* palms (Palms 4, 5 and 6).

Number of seed germinations per fruit	Palm 4	Palm 5	Palm 6	Total
n =	21	13	143	177
1	71.4	100	56.6	61.6
2	28.6	0	32.2	29.4
3	0	0	11.2	9
4	-	-	0	0

and 78.5 m^2, respectively) below Palm 4, 5 and 6 were considered for this study. The following itens were measured for each fruit: its position in relation to the soil surface (above soil, partially or completely buried); the number of germinations, the number of seeds and their viability (cut test), which were also measured on 30 fruits with no germination as found beneath Palm 4, 5 and 6. It was not possible to distinguish between fruits of the current year (fruiting period Sept. to Dec. 1997) or of earlier fructifications. The fruits from 1997 had not yet experienced a fire. The seedlings were classified into three stages of development by their leaf characteristics: stage 1 – initial development with only a few divisions of the leaf blade; stage 2 – division of the leaf blade with fewer than 200 leaflets/leaf ; stage 3 – still young without a trunk (acaulescent) with more than 200 leaflets/leaf.

Experimental seed germination study

Fruits of *babassu* used for this study all came from one mature infrutescence cut off an adult palm in the field study site near Marabá. The fruits were collected on 7 September 1995, and transported by air freight to Manaus the next day. The 150 fruits were maintained at 25 ± 5°C with 65 ± 5% r.h. until the commencement of the experiment on 26 September 1995.

The study site was located on INPA campus in Manaus. The sun-exposed site was an area with bare soil in an open field with some fruit bushes, the experimental plots received no shade during the whole day. The shady forest site was located about 50–100 m from the first site, in an old secondary forest with trees up to 15–20 m in height. There the soil was kept moist during the whole year by a small creek.

In the experimental study the whole fruit was planted as in nature. The following six treatments (T1–6, Table 5) were chosen to compare germination of buried (soil depth more than 3 cm) and exposed fruits, in sun (open field) and shade (forest) conditions besides the effect of a

Table 4: Stages of seedling development found beneath *Attalea speciosa* palms (Palm 4, 5 and 6). + = connected; – = disconnected seedlings.

Stage of Seedling Development		Palm 4 Seedlings (%)		Palm 5 Seedlings (%)		Palm 6 Seedlings (%)		All Seedlings
		+	–	+	–	+	–	(%)
Stage 1	ligule only	9.7	0	1.2	0	1	0	1.7
	initial germination	12.9	0	0	0	3.3	0	3.3
	seedling with 1 leaf	58.1	3.2	6.2	2.5	28.7	2.9	29.4
	seedling with 2 leaves	6.5	0	8.6	23.5	37.8	16.0	46.1
	seedling with 3 leaves	0	0	0	27.2	1	5.9	10.3
	seedling with 4 leaves	0	0	0	14.8	0.3	2.0	4.5
	seedling with≥ 5 leaves	0	0	0	7.4	0	0.3	1.7
Stage 2	<200 leaflets/leaf	0	6.5	0	7.4	0	0.7	2.4
Stage 3	>200 leaflets/leaf	0	3.2	0	1.2	0	0.3	0.7
Total number of seedlings		31		81		307		419

1. Erect *babassu* palm (Palm 6) with a stem of 2.5 m in height, showing three infrutescences of the year still maturing and traces of nine older infructescences.



three week exposure and a brief, moderate fire: For the last treatment (T6) the fruits were exposed to the sun on the soil surface during 3 weeks, and experienced a brief moderate fire before being buried. The fire lasted about 15 min during which circa 400 l of dry mango leaves burned, which had covered the fruits to about 50 cm in height. All fruits were carefully dug out 18 months later, on 17 April 1997. On this occasion the number of germinations per fruit and the leaves of the seedlings were counted. In fruits with no germination, the viability of the seeds was checked by cutting open the fruit (cut test).

2. The indehiscent fruits of *babassu* contain between one and four seeds. Fruits with different seed numbers can be found in the same infructescence.



Table 5: Effect of experimental treatments on germination of *Attalea speciosa* with 18 months observation.

Treatment	Number of fruits	Fruits with: germinated seeds (%)	not germinated seeds (%)	all seeds deteriorated (%)
T1 sun+exposed *	24	20.8	0	79.2
T2 sun+buried	25	76.0	0	24.0
T3 shade+exposed *	19	78.9	5.3	15.8
T4 shade+buried	25	100.0	0	0
T5 3 weeks+sun+buried	25	84.0	5.0	11.0
T6 3 weeks+fire+sun+buried	25	56.0	0	44.0

* 25 fruits planted initially in every treatment, some of the exposed fruits disappeared during the 18-month observation period.

Table 6: Experimental germination as a function of sowing conditions and previous treatment of the fruit, 18 months after beginning of the experiment.

Treatment		Number of germinations per fruit* 1	2	3	4	Seed germination of all planted fruits**	Seedlings/ Fruit**
	n	(%)	(%)	(%)	(%)	(%)	
T1 sun+exposed***	24	20.8	0	0	0	29	1.4
T2 sun+buried	25	24.0	32.0	20.0	0	176	2.3
T3 shade+exposed***	19	15.8	26.3	36.8	0	163	2.1
T4 shade+buried	25	36.0	36.0	24.0	4	196	2.0
T5 3 weeks+sun+buried	25	36.0	36.0	12.0	0	180	2.1
T6 3 weeks+fire+sun+buried	25	28.0	16.0	12.0	0	100	1.8

* Only fruits which showed any germination were considered; disconnected seedlings were not be included in the calculation.

** including disconnected seedlings : T1, 2 seedlings disconnected from fruit, T2, 7 seedlings, T5, 9 seedlings and T6, 1 seedling, assuming that disconnected seedlings come from germinated fruits.

*** 25 fruits planted initially in every treatment, some of the exposed fruits disappeared during the 18-month observation period.

Results

Field study

Fruit and seeds

The indehiscent fruits contained between one and four seeds (Figure 2). Even fruits from the same infrutescence had variable seed numbers. Comparing the fruits (n = 498) of the six palms under study (Table 1), fruits with four seeds were quite rare (less than 8%) and only 13% of the fruits had one seed. Fruits with two or three seeds were the most common with 33% and 46%, respectively. Average seed number was 2.5. However, the proportion of fruits having one, two, three or four seeds varied according to the palm.

Fruit dispersal and natural regeneration

Dispersal of the heavy fruits of *babassu* happens by gravity; they fall just beneath the mother tree. 85 to 100% of the fruits with germinated seeds were encountered within a circle 0–2 m of the adult stem. During their daily rests in the shade of *babassu*, cattle trampled the fruits into the soil beneath the palm (Figure 3). Displacement of the fruits by cattle or men walking in the pastures, or sometimes by running water was observed.

Seed germination

Of the 267 fruits, germinated or ungerminated, gathered beneath Palm 4, 5 and 6, all seeds were viable in 54% of the fruits, 13% had only one bad seed, 24% only one good seed and in 9% all seeds

had lost viability. Most of these fruits came from Palm 5. In total the fruits examined contained 654 seeds of which 29% were deteriorated. In the 191 damaged seeds, we observed 21 living larva of *Pachymerus nuclearum*, called "gongo." The factors which caused deterioration of the other 170 seeds could not be identified.

Most germinations were observed in buried fruits. In the field study, of the 177 fruits beneath the three selected palms, 71% of germination originated from completely buried fruits and 18% from fruits which were partly buried (Table 2).

The number of germinations per fruit is not constant. Only one seed had germinated in 62% of the fruits, whereas two seedlings were observed in 29% of fruits and less than 10% of the fruits had three seedlings. (Table 3). Palm 6, the oldest, presented most of the double or triple germinations.

Germination of seeds in pasture is subject to the combined action of several factors, such as annual fires, exposure to the sun and burying of the fruits. Regeneration below the mother tree showed the capacity of this species for germination in the pasture.

Plant development

Most of the recruitments (75%) below Palms 4, 5 and 6 had only one or two leaves (Table 4). The more advanced stages in seedling development were observed in less than 20% of the plants. Young individuals of more advanced stages are found in general in a greater distance from the adult palm and were often already disconnected from their originating fruit.

Experimental seed germination study

Seed germination

Eighteen months after implementation of the experiment the fruits were excavated. Nearly all seeds had either germinated or deteriorated (Table 5).

Sun exposure gave rise to seed deterioration, especially when the fruits were left above the soil during the 18 months (T1). Under this condition 79.2% of fruits had all their seeds damaged . On the same site, burial of the fruits reduced the seed deterioration to 24% (T2). In the forest, even above the soil, many seeds maintained their viability during the 18 months, and only 15.8% of the fruits had all their seeds deteriorated (T3). Burial on this site protected the seeds completely from deterioration (T4). A three-week exposure to sun (T5) did not affect seed deterioration, but a moderate fire of about 20 min (T6) caused a considerable rise in deterioration of the seeds, and 44% of the fruits had all their seeds damaged.

The forest floor seems to be the ideal site for germination of *babassu* seeds, here more fruits had seedlings or still viable seeds, compared to the open field conditions (Table 5). However, even in the forest, fruits above the soil (T3) had less seed germination than buried fruits (T4). This decrease of germination by leaving the fruits above the soil (T1) was confirmed under sun exposure (T2), there the decrease was even greater. Short (3 weeks) exposure to the sunlight before fruit burial (T5) had no negative effect on germination. On the other hand a quick fire (T6) reduced the germination success considerably.

Table 7: Stages of seedling* development 18 months after applying six experimental treatments to *Attalea speciosa* fruits (n=25). Values expressed in percentage of germinated seeds.

Treatment (as in Tab. 6)	Total Number of Germinated Seeds * n=	Stage of Seedling Development (%) Ligule not intact cut or deteriorated	Ligule intact without aerial part	Ligule intact with aerial part	Seedlings Leaf number 1	2	3	4	≥5
T1	7	14.3	0	14.3	71.4	0	0	0	0
T2	44	11.4	0	0	22.7	45.5	4.5	6.8	9.1
T3	31	0	29.0	38.7	32.3	0	0	0	0
T4	49	2.0	0	4.1	89.8	4.1	0	0	0
T5	45	20.0	0	2.2	8.9	44.4	8.9	0	15.6
T6	25	8.0	0	0	8.0	52.0	16.0	0	16.0
Total	201	18	9	16	75	55	10	3	15

* Total number, including seedlings disconnected from the fruits.



3. Cattle during their daily rest in the shade of *babassu*.

Under sunny conditions, if the fruits were above the soil (T1), only one (rarely two, considering disconnected seedlings) of the possible two, three or four seeds survived to germinate (Table 6). With burial of the fruits or in the shady forest, the possibility for the emergence of more seedlings per fruit increased. Besides one exceptional germination of four seeds/fruit (T4: Figure 4), the fruits showed up to three seedlings with an average of 1.8–2.3 seedlings/fruit.

Considering seedling emergence in relation to sown fruits, the highest germination success was observed when the fruits were either buried (T2, T4, T5) or left under shade in the forest (T3). Even after a moderate fire, germination was higher (T6) than in unburied fruits under sun-exposed conditions. This lower germination caused an obvious decrease in the number of seedlings per fruit for these treatments.

Plant development

Seedling development was evaluated by the number of leaves 18 months after initiation of the experiment (Table 7). The great majority of the seedlings in the understory with fruits above the soil showed only ligules (T3). The rest had one leaf only. In the same environment but with buried fruits we observed only 6 % of the seedlings in ligule stage, and a large majority of 90% were in the seedling stage with one leaf per plant; very few had two leaves (T4).

In the open sun site, when fruits were above the soil (T1), we observed only the initial stage of germination and plants with one leaf. In the same sun-exposed conditions in all other treatments (T2, T5, T6) in which the fruits were buried, the majority of the plants had two or more leaves (maximum 10).

Discussion

Babassu fruits: number of seeds, fruit dispersal and deterioration factors

In Marabá the average number of seeds per fruit was 2.5 and not more than four seeds were found in one fruit. This is lower than in Maranhão, where the average seed number was 3.1 (Anderson & May 1985) and fruits with six seeds (Carvalho et al. 1988), seven seeds (Uhl & Dransfield, 1987) and even 11 seeds (May et al., 1985a) were observed.

The heavy fruits fall below the palm and 85–100% of the fruits are found within a radius of 0–2 m

around the stem. The fruits, therefore, depend on secondary fruit dispersal. The red-rumped-agouti (*Dasyprocta agouti*) and paca (*Agouti paca*) are rodents that consume the mesocarp (Anderson 1983, Mitja et al. 1998), and both animals were observed in the forest (May et al. 1985b, Anderson et al. 1991), as well as in pastures (Smith 1974). In open fields the red-rumped agouti is more important, and fruit dispersal of *babassu* from one property to the next depends on this rodent (Mitja et al. 1998). Displacement of the fruits by accidental intervention by man or livestock and sometimes by running waters was also observed.

Babassu has an indehiscent, very hard fruit, which is difficult to break. The seeds are protected by the endocarp from most of the potential animal predators; thus man remains the main predator of *babassu* as he can use tools (Anderson & May 1985), plus the larva of *Pachymerus nuclearum*, which uses the germination pore to enter the fruit and consume the seed (May et al.1985b). Anderson and May (1985) observed in Maranhão that within three months 70% of the fruits were colonized by the larva of *Pachymerus nuclearum*. Often these larvae did not attack all seeds in the same fruit, allowing some of the seeds to germinate (Anderson et al. 1991). In the present study the fruits had probably lain 8–11 months below the palms, some even longer. All seeds were viable in 54% of the fruits, and of the 654 seeds examined, only 29% had lost their viability. Only 11% of the 191 damaged seeds showed a living larva. A distinction between seeds damaged by the larva of *P. nuclearum* or by prolonged exposure to sun or by the effect of fire was not possible. However, we can conclude that larval damage is less pronouced in Marabá than in the sudy in Maranhão. The fruits used in the experimental studies were all collected directly from the palm in Marabá, and on the study site in Manaus *babassu* did not occur. It is, therefore, probable that the fruits were not contaminated by the larva *P. nuclearum*. Indeed, at the final measurements after 18 months, no larvae of *P. nuclearum* were observed.

Flowering of *Attalea speciosa* is widely synchronized over a vast geographical area (Anderson et al. 1991). Fruiting occurs during the dry season with a peak of fruit falling during October–December (Anderson et al. 1991). In Marabá, fires normally take place in August, thus the fruits have a period of 8–11 months during which they may germinate or become buried by livestock. Thus experimental studies have elucidated the importance of the microenvironment on seed longevity under field conditions.

Burial of the fruits can extend seed longevity and is far more important in the pasture than in the forest. After remaining 18 months at the sun-exposed site, only 24% of the buried fruits had lost all their seeds to deterioration. The percentage rose to 79.2% if the fruits were left on the soil surface. In the forest, where the relative humidity was higher and the temperature less fluctuating, none of the buried fruits had lost all their seeds, but 15.8% did so if they remained on the soil surface.

Loss in seed viability was also observed if the fruits experienced a fire of moderate intensity during a three-week exposure in the sun; here 44% of the fruits lost all their seeds (T6), compared with only 11% in the control treatment (T5).

Under extreme microclimatic conditions such as prolonged exposure to the sun in pastures and in areas subjected to slashing and burning, seed deterioration of *A. speciosa* can be avoided only by burial of the fruits, and the main agents in the pasture of Marabá are the cattle and the red-rumped agouti.

4. Four germinations were observed on a completely buried fruit in the understory.



Germination and environmental factors

Multiple germination can be observed in the field as well as under experimental conditions. The number of seedlings per fruit was related to environmental factors.

In the primary forest high regeneration and many seedlings are typical for *A. speciosa* (Kahn & DeGranville 1992). However, even in the forest the burial of fruits favored germination and, as in our study, all fruits (100%) had at least one seedling. In the forest, independent of whether the fruits were buried or not, germination was often multiple, and the average was two seedlings per fruit.

An intense burn following the cutting of the forest will probably damage most of the seeds in fruits left on the soil surface. A quick and less intensive fire experimentally reduced the number of seedlings from 45 to 25 and consequently the number of seeds germinated per fruit from 2.1 to 1.8.

After forest clearing, even in pastures, fruit production of adult *A. speciosa* continues to be annual. However, the microclimatic conditions to which the fruits are exposed change drastically. Prolonged sun exposure (18 months) reduced germination and only 20.8% of the fruits had a seedling, averaging 1.4 germinations per fruit. If the fruits are buried the germination increases to 76%, and a fruit showed on average 2.3 germinations. A short three-week exposure to sun with subsequent burial of the fruits did not reduce the performance.

Under field conditions in the pastures of Marabá, the majority (89%) of the fruits which showed any seed germination were partially or completely buried. Most fruits had one seedling (62%), two seedlings were detected in 29% and only 9% of the fruits had three seedlings.

Seedling growth and environmental factors

Whereas germination was encouraged in the shady environment of the forest, seedling growth was slow, and even stagnated. After 18 months, if the fruits remained on the soil, the majority of the seedlings (68%) had just a ligule, and a minority (32%) just one leaf. With burial of the fruits, development was slightly accelerated, and 90% of the seedlings had one leaf, and 4% two leaves. On the sun-exposed site with fruits above the soil, the seedlings had at most one leaf. If the fruits were buried, most seedlings (66%) had two or more leaves with a maximum of ten leaves. Thus, if the fruits are buried, a sunny environment stimulated seedling development, in contrast to forest conditions.

In the pastures near Marabá, the seedling age was not known, but based on the experimental data some seedlings might have been more than 18 months old, as they had more leaves and a considerable proportion of seedlings were disconnected from the fruit from which they originated. Survival of these seedlings in the pastures is probably related to the fact that the terminal meristem is below ground (Anderson 1983, Anderson et al. 1991). The young seedling can regenerate even if the aerial part is burned.

Conclusions

Field observations and experiments provided data on environmental conditions for the seed viability, germination and establishment of *babassu* (*Attalea speciosa*).

Indehiscent fruits were not subject to predation but long sun exposure or moderate fire increased seed deterioration and consequently decreased seed germination. Conversely, germination was improved by moisture either inside the forest or if fruits were buried. In open field conditions, generally only one seed per fruit germinated, rarely two, but under moist conditions, shade or buried fruits, multiple seedlings were often observed. Accordingly, the present study demonstrated that in an open environment burial was the most important factor for seed viability and multiple germinations per fruit. The action of cattle trampling the fruits in the soil and burial by red-rumped agouti may be the major cause of proliferation of *babassu* in pasture near Maraba.

Seedling growth was considerably enhanced by sun exposure. In the shade, seedlings may remain suppressed for a long time. These characteristics together with seedling capacity to regenerate after a fire (even if the aerial part is completely burned) may explain why *babassu* can become dominant in the tropical pastures of the Amazonian region.

In pastures, elimination of seedlings and young palms involves cost (herbicide) and labor. Fruit dispersal is limited to a small area around the stem, and seed germination needs a long time. Under present social and economic conditions of northern Brazil, the control of the *babassu* plant population can be undertaken by promoting fruit removal, especially when fruits can be used, as for example for charcoal. Special attention must be paid to avoid burial of the fruits by cattle.

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Coconut Varieties and Lethal Yellowing: A Regional Perspective for the Americas

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The local tall coconut palms on the Atlantic and Caribbean coasts of America are highly susceptible to lethal yellowing disease (LY) whereas those on the Pacific coast have a degree of resistance that reduces the risk of an epidemic of this disease. Resistant varieties and hybrids are available, and research and development are accessible on the Internet.

The year 1999 was the 500th anniversary of the introduction of coconut to the Western hemisphere (Harries 1977). They were carried back to Portugal by Vasco da Gama in 1499 from India or East Africa and en route some were left at the Cape Verde Islands. Within 50 years, by 1549, records show that coconuts from Cape Verde were taken to Brazil and to Puerto Rico. They would have reached the Atlantic and Caribbean coasts of other Latin American countries, as well as the Atlantic coast of Africa, quite quickly because, at that time coconuts were carried on all sailing ships as a source of water and they were planted wherever sailing ships called for just that purpose. The coconuts on the Pacific coast of Central and South America arrived at about the same time in the mid-16th century and for the same reason but came from Manila in the Philippines. They were different from the Caribbean Atlantic coastal coconuts and the two populations have remained distinct, with a few exceptions, to this day (Harries 1971). There was no trade in copra or coconut oil at that time but the most important point to understand is that there could have been no epidemic diseases or serious pests present to prevent successful establishment because within 500 years coconuts were everywhere in America.

Over the last one hundred years the role of coconut changed. Steamships, making quicker journeys and carrying tanks of fresh water for the boilers, no longer needed to carry coconuts for drinking. Instead, cargoes of copra (the dried endosperm) were carried because coconut oil became the most important source of vegetable oil for margarine, soaps and explosives (nitroglycerine). This was particularly so at the time of the first World War, when plantations were established, and after the Second World War when a world-wide edible oil shortage encouraged expansion of coconut planting in Mexico and Brazil (and stimulated the soybean industry in the USA).

Global and regional threat

With the economic importance of the coconut came the first reports of serious diseases (coinciding with a scientific interest in agricultural diseases generally). From the descriptions it is hard

to be sure if fungal, bacterial or physiological causes were being recorded. For instance, bud rot, which is common wherever coconuts (or other palm species) grow was widely reported (in English, French, German and Spanish speaking countries), whilst red ring, also a serious problem, seems to be of South American origin. The most important problem, lethal yellowing, which became notorious because it was epidemic, is now known to be caused by a phytoplasma (formerly called an MLO or mycoplasma-like organism) and transmitted by a planthopper vector. It seems likely that LY was introduced to the region when vectors were unintentionally carried on other plants (possibly on grass) from south-east Asia at a time when both colonial authorities and amateur horticulturists were keen to move plants and before there were strict quarantine regulations.

Although lethal yellowing disease is thought to have been recognised about one hundred years ago it came into prominence only about forty years ago in Jamaica, thirty years ago in Florida, twenty years ago in Mexico and five years ago in Honduras. Its potential for spread is unlimited, but the rate cannot be easily predicted. An infected palm, of any variety, will die within four to six months of the first symptom. In an area of susceptible Atlantic coast tall cultivar, almost all palms may die within four years. A few will escape and may subsequently die if another epidemic cycle starts. If a block of Malayan Dwarf are present in an epidemic area, the disease eliminates a few, but most survive. When LY became epidemic in Jamaica the Coconut Industry Board began a replanting programme with the highly resistant Malayan Dwarf variety. The CIB also made major germplasm collections to look for other sources of LY resistance and these resulted in the production of the Maypan hybrid in 1974.

The method for large scale hybrid coconut seed production was introduced to other countries and specifically to Costa Rica in 1977. Observations made during the visit to Costa Rica crystallised ideas on coconut evolution and the identification of wild-type, domestic-type and introgressed-types of coconut varieties. This had particular application to LY disease resistance in three ways: the origin of LY resistant varieties in south-east Asia; the prediction that LY type diseases would be found in southeast Asia; and the assessment that LY presented a threat to about 62% of the world's coconut palms (Harries 1978).

During that period of intense LY research an International Council on Lethal Yellowing was established and held four meetings. ICLY subsequently ceased to function but has recently been revived, on the internet, as the Centre for Information on Coconut Lethal Yellowing (CICLY) <http:// www.cicy.mx/dir_acad/cicly/main.html> and an associated e-mail discussion group <http:// groups.yahoo.com/group/CICLY> on the internet. CICLY is an attempt to provide a clearing house for information on LY-type diseases and is a new approach that benefits from research done on LY in Mexico, on similar diseases in East and West Africa and on recent findings in southeast Asia.

One recent outcome of research is the possibility of ranking varieties on a 1 to 5 scale of resistance-susceptibility:

Malayan Dwarf (MD)	=	1
MD × PT	=	2
Panama Tall (PT) and also MD × AT	=	3
PT × AT	=	4
Atlantic Tall (AT)	=	5

Varieties behave differently with respect to LY disease. The Malayan Dwarf (MD) is highly resistant and, as a result, the disease is not epidemic or is no longer epidemic where this variety has been widely planted. The Pacific coast tall (PT) has shown intermediate resistance when planted in epidemic areas, and the dwarf × tall hybrids (MD × PT and MD × AT) are intermediate between the respective parents in trials. Thus there are five apparent degrees of resistance or susceptibility: MD > MD × PT > PT > MD × AT > AT. In Jamaica the difference between 1 and 5 (MD and Jamaica Tall (JT)) is very clear. In Tanzania, the differences are not so clear cut, perhaps because the strain of the phytoplasma is different, and different East African Tall (EAT) accessions are located at 2, 3 and 4 on the scale (Harries 1995).

Another outcome, based on accumulated information, is a reduction in the global threat by a few percentage points (from 62 to 58 based on calculated areas of cultivated coconuts) or even more, if the disease fails to become epidemic in areas, like the Pacific coast, where resistant varieties predominate. This reassessment of the threat of LY applies mainly within the Latin American region. Lethal yellowing is currently epidemic on the Caribbean coast from Mexico to Honduras where the Atlantic coast tall (AT) is highly susceptible. The disease has not yet spread to the Pacific coast and, although phytoplasma have been associated with a yellowing decline condition, this is non-epidemic. Lethal yellowing may not become epidemic on the Pacific coast because resistant coconut varieties (or other immune palm species) can slow or prevent its spread.

Conclusions

Where large areas of resistant material occur the disease ceases to be epidemic. It has been suggested that the disease and the resistant varieties co-evolved in south-east Asia, where non-epidemic yellows diseases have recently been associated with phytoplasma. Further research is required to ascertain the closeness of the relationship and the relative pathogenicity of phytoplasmas associated with coconut palms in the various regions. However, in the present state of knowledge, it is hoped and believed that LY will not become epidemic on the Pacific coast of the Americas. Similarly, the best way to slow or stop the spread along the Atlantic coast is to replant with resistant varieties and hybrids before the disease arrives.

Areas such as Jamaica and Florida, have lower risk because of the replanting with resistant material. In areas of new LY outbreaks, in Mexico, Belize and Honduras, the same option should also work. Those areas where the disease has not yet arrived (such as Brazil or Costa Rica) or become epidemic (such as Dominican Republic) can benefit if the same precautions are taken. It has to be borne in mind that LY is not the only threat in the Americas. There may be other phytoplasma-related yellows and there are phytomonas and red ring. Nevertheless, the potentially large markets for value-added coconut products on the American continents, gives producers in the region an advantage over older, traditional areas of production in south-east Asia.

Acknowledgments

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Growth Rates of Palms in Fairchild Tropical Garden

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One of questions we are most frequently asked concerning palms is, "How fast do they grow?" Reference books may give relative terms, such as "slow" or "moderately fast," but actual growth rates are seldom reported. Spurred by questions from fellow palm enthusiasts, we present the following growth rate data gathered from seed-grown palms in Fairchild Tropical Garden, Miami, Florida, USA.

The palms included in our sample were chosen at random, according to accessibility and availability of records. We measured the height of single-stemmed palms from the ground (or the top of the root mass) to the bottom of the sheathing leaf base (where the lowest live leaf attaches to the stem). In other words, neither the crownshaft nor crown was included in height measurements; only the trunk was measured. For certain palms in which the bottom of the leaf base was obscured by dead leaf base fibers (certain *Coccothrinax*, for example), we visually estimated the position of the base of the lowest live leaf and measured from there. We used a measuring rod graduated in centimeters (Hastings Tools & Equipment, Hastings, Michigan) that telescoped to 750 cm, supplemented with a measuring tape, as needed. Age was determined from the year in which the seeds were received by Fairchild Tropical Garden. Stem height was divided by the age of the palm to give the growth rate, expressed in cm/yr and rounded to the nearest centimeter.

In interpreting the growth rates given here (Tab. 1), certain caveats apply. First, these rates are lifetime average growth rates. They do not take into account the variation in growth rate over the life of a palm, which may grow quickly as a juvenile but slowly as a reproductive adult. These rates do not take into account the pre-germination period, which may be many months in certain Cocoeae, nor do they account for the establishment phase, during which a seedling palm may form no above-ground stem. Second, these rates are taken from individual palms growing in Miami whose growth rates may not be typical. Palms grown elsewhere may have significantly different growth rates (slower or faster).

Our results (Tab. 1) indicate, not surprisingly, that considerable variation exists in average growth rates. In instances where we measured several individuals from the same seed lot (individuals sharing the same accession numbers but with different letter suffixes – *Calyptronoma rivalis* and *Ravenea rivularis*, for example), growth rates may vary two-fold or more. The four fastest-growing palms in our sample are *Livistona robinsoniana*, *Carpentaria acuminata*, *Bentinckia nicobarica* and a young *Ptychosperma salomonense*. The slowest palms in our sample are two Bahamian accessions of *Pseudophoenix sargentii* ssp. *saonae* var. *saonae* and an individual of *Ravenea hildebrandtii*. The

difference in rates between the slowest and fastest palms is greater than twenty-fold.

Growth rates are governed by the interplay of genetic factors and external factors, such as availability of light, water, nutrients, etc.; however, we are unable to determine which of these factors is the most important in explaining the tremendous variation in our data. Nevertheless, we hope these data will give growers of palms some idea of the growth rates that can be expected for these species and that the data will be useful in making informed planting decisions.

Acknowledgments

We thank Dena Garvue for the use of the measuring rod, and we thank Chuck Hubbuch for reviewing the manuscript and offering useful suggestions.

Table 1. Average growth rates of palms growing in Fairchild Tropical Garden. The growth rate can be converted into inches per year by dividing the figure by 2.54.

Taxon	Accession Number	Height (cm)	Age (yr)	Rate (cm/yr)
Aiphanes minima	70304A	669	30	22
Areca catechu	8334C	558	17	33
Areca catechu var. *longicarpa*	87299B	276	13	21
Astrocaryum mexicanum	5930A	213	41	5
Bentinckia nicobarica	88107B	536	12	45
Bentinckia nicobarica	83150C	809	17	48
Bismarckia nobilis	73201A	357	27	13
Bismarckia nobilis	68263A	378	32	12
Borassodendron machadonis	581026A	339	42	8
Borassus aethiopum	58152C	744	42	18
Borassus aethiopum	58152D	656	42	16
Brahea armata	70127B	580	30	19
Brahea brandegeei	59679	700	41	17
Brassiophoenix drymophloeoides	68251A	376	32	12
Calyptronoma rivalis	81292A	275	19	14
Calyptronoma rivalis	81292B	141	19	7
Carpentaria acuminata	89213A	567	11	51
Caryota cumingii	77961C	505	23	22
Clinostigma samoense	79218G	461	21	22
Clinostigma samoense	79218J	515	21	25
Coccothrinax argentata	88411A	142	12	12
Coccothrinax argentea	4648B	948	54	18
Coccothrinax argentea	84255B	577	16	36
Coccothrinax barbadensis	59740D	431	41	11
Coccothrinax inaguensis	58650A	281	42	7
Coccothrinax litoralis	58534A	340	42	8
Coccothrinax miraguama ssp. *roseocarpa*	60798H	504	40	13
Coccothrinax proctorii	59627A	528	41	13
Coccothrinax proctorii	80724B	261	20	13
Coccothrinax proctorii	6220A	159	38	4
Coccothrinax proctorii	6220D	174	38	5
Coccothrinax scoparia	58839B	561	42	13
Coccothrinax spissa	58477A	444	42	11
Copernicia alba	6458B	716	36	20
Copernicia baileyana	6235A	568	38	15
Copernicia curtissii	6912A	265	31	9
Copernicia hospita	60532F	229	40	6
Copernicia hospita	60532H	209	40	5
Copernicia macroglossa	71443E	434	29	15
Copernicia prunifera	60810A	401	40	10

Copernicia rigida	57725E	215	43	5
Copernicia yarey	59971A	247	41	6
Copernicia yarey	59971D	241	41	6
Cryosophila stauracantha	8089A	434	20	22
Cryosophila stauracantha	8089B	349	20	17
Cyphophoenix nucele	74344C	253	26	10
Cyrtostachys loriae	81225C	312	19	16
Dictyosperma album var. *album*	88207B	289	12	24
Dictyosperma album var. *aureum*	88373A	255	12	21
Drymophloeus litigiosus	73314B	268	26	11
Drymophloeus oliviformis	75453A	216	25	9
Drymophloeus pachycladus	65982D	630	35	18
Drymophloeus subdistichus	75396A	582	25	23
Drymophloeus subdistichus	75396B	813	25	33
Dypsis decaryi	80528B	218	20	11
Gastrococos crispa	661023A	688	34	20
Gastrococos crispa	661023B	693	34	20
Gaussia attenuata	7184E	780	29	27
Gaussia attenuata	79558E	539	21	26
Gaussia princeps	58797F	644	42	15
Gulubia costata	80106A	322	20	16
Gulubia macrospadix	87504A	488	13	38
Heterospathe salomonensis	73480D	318	27	12
Hyophorbe lagenicaulis	581174B	269	42	6
Hyophorbe lagenicaulis	581174C	228	42	5
Hyophorbe lagenicaulis	58687E	280	42	7
Hyophorbe verschaffeltii	72781A	322	28	12
Hyphaene thebaica	58837H	712	42	17
Kentiopsis oliviformis	77146C	409	23	18
Latania loddigesii	75460A	284	25	11
Latania loddigesii	72519A	358	28	13
Licuala grandis	6145B	206	39	5
Livistona benthamii	84294C	339	16	21
Livistona decipiens	82383A	399	18	22
Livistona decipiens	82383B	339	18	15
Livistona decipiens	62207G	795	38	21
Livistona inermis	84233A	215	16	13
Livistona mariae	57787C	873	43	20
Livistona mariae	57787D	795	43	18
Livistona merrillii	80659B	577	20	29
Livistona nitida	84376A	259	16	16
Livistona robinsoniana	8310A	925	17	54
Livistona woodfordii	591028A	545	41	13
Livistona woodfordii	591028B	741	41	18
Normanbya normanbyi	66656B	460	34	14
Normanbya normanbyi	74472C	512	26	20
Orania palindan	85370A	190	15	13
Pseudophoenix lediniana	74393A	287	26	11
Pseudophoenix lediniana	63198A	674	37	18
Pseudophoenix sargentii ssp. *saonae* var. *navassana*	60171D	697	40	17
Pseudophoenix sargentii ssp. *saonae* var. *navassana*	60171S	215	40	5
Pseudophoenix sargentii ssp. *saonae* var. *navassana*	60171U	273	40	7
Pseudophoenix sargentii ssp. *saonae* var. *saonae*	5880A	103	42	2

Pseudophoenix sargentii ssp. *saonae* var. *saonae*	5880B	100	42	2
Pseudophoenix sargentii ssp. *saonae* var. *saonae*	60183A	248	40	6
Pseudophoenix sargentii ssp. *sargentii*	58872	291	42	7
Pseudophoenix sargentii ssp. *sargentii*	591181G	113	41	3
Pseudophoenix sargentii ssp. *sargentii*	82441A	159	18	9
Pseudophoenix vinifera	81401A	209	19	11
Ptychococcus ledermannianus	75171C	405	25	16
Ptychosperma caryotoides	74263D	346	26	13
Ptychosperma pullenii	81590K	213	19	11
Ptychosperma salomonense	85181A	459	15	31
Ptychosperma salomonense	951038A	227	5	45
Raphia farinifera	66748A	284	34	8
Ravenea rivularis	76985C	510	24	21
Ravenea rivularis	76985D	250	24	10
Ravenea hildebrandtii	61378N	162	39	4
Ravenea hildebrandtii	61378P	91	39	2
Roystonea princeps	66674B	690	34	20
Roystonea princeps	66674D	878	34	26
Roystonea princeps	64563C	722	36	20
Sabal domingensis	67269C	369	33	11
Sabal mauritiiformis	6312C	796	37	22
Sabal palmetto	581008A	263	42	6
Sabal yapa	59492A	235	41	6
Sabal yapa	57690F	259	43	6
Sabal yapa	57690G	204	43	5
Sabal yapa	60458C	325	40	8
Satakentia liukiuensis	68317D	438	32	14
Satakentia liukiuensis	68317E	470	32	15
Satakentia liukiuensis	68317F	499	32	16
Satakentia liukiuensis	68317J	374	32	12
Satakentia liukiuensis	68317M	725	32	23
Schippia concolor	79553B	228	21	11
Schippia concolor	591200D	233	41	6
Schippia concolor	591200F	283	41	7
Schippia concolor	5759A	418	43	10
Siphokentia beguinii	59969C	461	41	11
Syagrus amara	80296E	358	20	18
Syagrus amara	80296L	621	20	31
Syagrus sancona	83132E	393	17	23
Syagrus × *costae*	62232C	470	38	12
Syagrus × *costae*	62232D	443	38	12
Syagrus × *costae*	59940D	271	41	7
Thrinax excelsa	83347B	232	17	14
Thrinax morrisii	58468K	116	42	3
Thrinax radiata	59460A	258	41	6
Thrinax radiata	67383B	282	33	9
Veitchia vitiensis	89204B	246	11	22
Wodyetia bifurcata	8234E	526	18	29

Horticulture Column

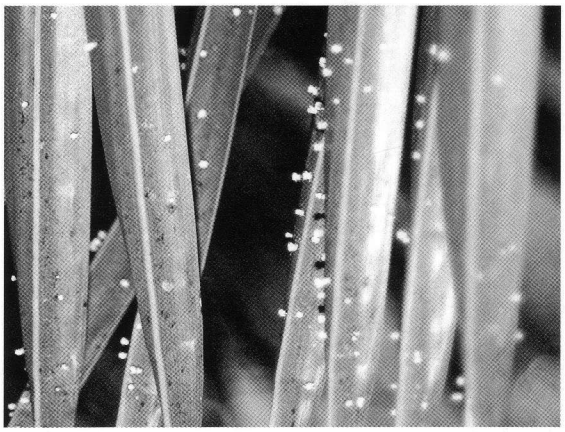
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Q. I grew some date palms, *Phoenix dactylifera,* from the seeds of dates that I bought at the grocery store. They are two years old now, and I have recently planted three of them in my yard. There are four others still in pots that I am going to give away. The new leaves always look better than the older leaves, but the oldest leaves are not just discolored, they are covered with rough, tan colored specks, especially under the leaves. When I touch the spots, colored powder gets on my hand. Is it a disease or an insect? John LaRue, Texas.

A. You are probably describing a very common fungus disease of date palms called false smut, *Graphiola phoenicis* (Fig. 1), and the tan colored powder that you noticed on your hand is the spores of this fungus. There is a fairly long list of palms that are said to be hosts of this disease but I have seen it only on *Phoenix* species that are native to arid habitats, namely, *P. canariensis, P. dactylifera, P. sylvestris* and *P. theophrasti.* All of these seem fairly susceptible, and at least in central Florida, young plants almost invariably have false smut on their lower leaves.

Fortunately this disease does not usually have much effect on the growth of an otherwise healthy palm. Fungicides, copper hydroxide or mancozeb for instance, can be used to help control this disease but finding a product labelled for legal use on palms might not be possible. If one follows a few precautions this disease can be kept in check without spraying. Date palms and the other *Phoenix* spp listed above are all best grown in full sun, even as young seedlings. Irrigation water should be kept off the foliage as much as possible. Keeping the foliage dry is perhaps more important in the prevention of other leaf spot diseases that can occur along with false smut. If plants must be watered with overhead sprinklers, one should avoid doing so late in the day or at night so that the foliage will have time to dry before sunset. Finally, removing the affected leaves before they deposit spores on the newer leaves can help to control false smut, especially if done in the fall, say, November in Texas or May in the Southern Hemisphere. It is important that you do not remove excessive numbers of leaves in an attempt to control this disease. The loss of green, functional leaves would be a cure that is worse than the disease. If more than a few leaves are infected with false smut, remove only the worst affected ones. I have observed that the ornamental species of *Phoenix* become less susceptible to false smut as they get larger, and I hope this will be the case with your date palms also.

1. The underside of a leaf of *Phoenix canariensis* infected with false smut, *Graphiola phoenicis.*



Note:

This piece is Bernie Peterson's last contribution to the Horticulture Column. The editors are grateful to Bernie for his many fine articles in this space, and we thank him for his service to the journal.

From now on, all Horticulture Column questions should be sent to Katherine Maidman, Fairchild Tropical Garden, 10901 Old Cutler Road, Coral Gables (Miami), Florida 33156 USA. Readers' questions can also be submitted to Katherine via e-mail at <kmaidman@fairchildgarden.org>.

THE EDITORS

